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REPORT
OF THE
WEST VIRGINIA
CONSERVATION COMMISSION
1908

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LETTER OF TRANSMITTAL.

To His Excellency, HONORABLE WM. M. O. DAWSON, *Governor of West Virginia:*

SIR:—The West Virginia Conservation Commission which you appointed in October of this year has the honor to transmit its report.

The time for the completion of the work was very brief and prevented as full and careful consideration as some of the topics merited. This is the first report of the kind every prepared for West Virginia, and there was no precedent to guide the Commission. It endeavored to blaze the trail in what it believed to be the right direction, if development and economy are to work hand-in-hand to utilize the States enormous wealth.

Very respectfully,
HU MAXWELL,
Chairman.
J. H. STEWART,
Secretary.

NOTE:—Mr. Neil Robinson, the third member of the Commission, was unable to meet with the other members.

PART I.

THE FIELD OF INQUIRY DEFINED.

The appointment of a National Conservation Commission something over a year ago was a new page in this country's industrial history. It was the first step taken in an official and effective way to ascertain what the resources of the United States are, to what extent they have been wisely used, and in what way more economy may be practiced without seriously or permanently retarding development. The idea originated with Glifford Pinchot, the head of the United States Forest Service. At his suggestion President Roosevelt appointed the National Commission and set it to work. It divided the country's natural resources in four general classes, Water, Forest, Lands, Minerals. A sub-committee was appointed to take up the investigation of each class.

One of the earliest suggestions was that the Governor of each of the States appoint a commission to take up the work in the States, following the same lines of investigation as the National Commission. It was further suggested that the State Commissioners should act with the National Commission where it was proper and advantageous to do so. All or nearly all of the States acted on the suggestion and appointed commissions. Governor Dawson, in October, 1908, named a commission of three persons, James H. Stewart, Neil Robinson and Hu Maxwell. This commission, two of the members being present, began work on November 3. The very short time in which the report must be finished was a serious handicap in making it full and complete. It was required to be in the hands of Governor Dawson in time to make use of such portions as he desired for the information of the legislature early in January.

West Virginia has resources of two kinds, exhaustible and inexhaustible. These terms should be used with caution, however, for it is possible to seriously impair or permanently destroy resources which properly fall in the inexhaustible class; and, conversely, it is possible to so protect and utilize the natural wealth of the other class that its use may be prolonged almost indefinitely. Minerals belong to the exhaustible class. If they are accumulating at all in the earth now, the process is so exceedingly slow that it may be left out of consideration. Coal can be burned but once. The empty mines never fill again. Natural gas is never replaced, nor is oil, or rock salt, or limestone, or iron, or any of the minerals. New supplies, if they come at all, must come from new discoveries, and as far as West Virginia is concerned, further discoveries on a large scale are not probable. This emphasizes the importance of putting to the best possible use what we have, and stopping waste and loss in all practicable ways. If the people of West Virginia do that, they will not see the end of their mineral resources for many a generation. On the other hand, waste and extravagance have run rampant, and if they continue, and grow as development grows, the end of some of the mineral resources will come very soon.

The list of resources which, with certain restrictions, may be called inexhaustible, is longer. It contains much that enters into the lives of the people. The land is inexhaustible, if men take care of it. If they do not take care of it, it will be gone sooner than almost anything else. The forests will live forever and yield their products forever, if necessary protection is thrown round them. Otherwise, they will disappear and leave nothing, so far as we can see now, to take their place. The rivers and natural waters will go on forever and supply men's needs, if men will do their part. But destruction of rivers, brooks and springs is not only possible but dangerously near a certainty, unless men exert themselves to save soil and forest. The natural scenery, with the hundred things that go with it, is an everlasting resource, with a financial, intellectual, and moral value; but it too, depends upon so many things that neglect or carelessness may bring irreparable ruin.

So it goes down the whole line. There is a condition attached to every good thing in the catalogue of natural wealth. In the past, people paid little or no attention to the conditions. They used, abused and wasted. The result can be seen by following the back track of civilization and see what it has left behind. Deserts, sand, rocks, salt, death and desolation where the nations of antiquity lived, tell the story of man's methods of subduing the earth.

There seems to be a turn of the tide now. The progressive nations of Europe have taken up the work of saving their forests and soil as though existence depended upon it—and it does. The United States—the youngest, richest, most intolerably improvident of them all—has taken the first side step from the downward road. Men who think, and men who do have the work in hand.

Two very stubborn influences must be overcome. The first is the persistence of those who can see no harm in continuing to do what they have always done. Habit is hard to break away from. But patience, perseverance, example, and education will finally win those who waste because they have not seen the harm in it.

The outlook is more discouraging when consideration is given to another class of destroyers. They do not waste because they do not know better, but because they think it pays them better. To that class belongs the lumberman who skins the land to the last post and pole, and passes on to new woods, leaving his late slashings a prey to fire. The oil producer who saves a dollar's worth of petroleum and permits five dollars' worth of natural gas to blow into the air, is of the same class. The manufacturer who pours waste into the natural streams and poisons them is of that class too. The coke maker who uses an oven which wastes by-products worth four dollars while making two dollars' worth of coke is in the same class.

The men who persist in doing this justify themselves by saying, or thinking, that a man can do what he pleases with his own property. That ground is not tenable. The public has rights which no man can violate without becomming a trespasser. Destruction, or waste, or injury of resources which the people need for use is not only morally wrong, but it is wrong in law also. This doctrine is not very old, but it is old enough to stand. Speaking to this identical point President Roosevelt said at the

Governors' Conference at the White House last May:

"On March 10, 1908, the Supreme Court of Maine rendered an exceedingly important judicial decision. This opinion was rendered in response to questions as to the right of the legislature to restrict the cutting of trees on private land for the prevention of droughts and floods, the preservation of the natural water supply, and the preventation of the erosion of such lands, and the consequent filling up of the rivers, ponds and lakes. The forests and waterpower of Maine constitute the larger part of her wealth, and form the basis of her industrial life, and the question submitted by the Maine senate to the supreme court, and the answer of the supreme court, alike bear testimony to the wisdom of the people of Maine, and clearly define a policy of conservation of natural resources, the adoption of which is of vital importance, not merely to Maine but to the whole country. * * * * * The opinion of the Maine supreme bench sets forth unequivocally the principle that the property rights of the individual are subordinate to the rights of the community, and especially that the waste of wild timber land derived originally from the state, involving as it would the impoverishment of the State and its people, and therefore defeating one great purpose of government, may properly be prevented by state restrictions.

"The court says that there are two reasons why the right of the public to control and limit the use of private property is peculiarily applicable to property in land. First, such property is not the result of productive labor, but is derived solely from the state itself, the original owner; second, the amount of land being incapable of increase, if the owners of large tracts can waste them at will without state restriction, the State and its people may be helplessly impoverished, and one great purpose of government defeated. * * * * * * The Court of Errors and Appeals of New Jersey has adopted a similar view, which has recently been sustained by the Supreme Court of the United States. 'The state,' says Chief Justice Holmes, 'has a standing in court to protect the atmosphere, the water and the forests within its territory, irrespective of the assent or dissent of the owners of the land most immediately concerned."

The knowledge that the people as a whole have the right to stop by law a waste which threatens serious injury, is the first step toward providing remedies for some of the existing evils. The knowledge that a remedy is within reach is not, however, all that is necessary. It is apparent from the history of the enormous waste of natural gas in West Virginia, with no step taken to stop it, that a good deal of public sentiment must back the man who tries to apply the remedy. It is evident that the necessary public sentiment has not existed heretofore in West Virginia.

Speaking on this subject—the waste of gas in this state—at the White House in Washington, and within an hour after the President's address, quoted above, was made, Dr. I. C. White, State Geologist of West Virginia said, addressing the Governors of all the state of the Union:

"For ten long years your speaker has appealed in his official capacity as State Geologist to the legislature of West Virginia to put some check upon this frightful waste of our State's most valuable resource. Three patriotic Governors, including our present able executive, Governor Dawson, have in every biennial message besought the legislative branch to end this criminal destruction by appropriate legislation, but some unseen power, greater than governors or legislatures, has so far thwarted and palsied every effort to save to the state and the nation this priceless heritage of fuel, so that, although five successive legislatures have attempted to deal with the question in biennial sessions, not an effective line has yet been added to the statutes, and at this very hour not less than 250,000,000 cubic feet of gas, and possibly more than double that quantity, is daily being wasted in this one state alone, 80 per cent of which is easily and cheaply preventable."

PART II.

THE EXHAUSTIBLE RESOURCES.

The Coal Fields of West Virginia.

The State Geological Survey estimates West Virginia's coal area at 6,080,000 acres, and the total quantity in the ground 60,800,000,000 tons of 2,000 pounds each. This includes good coal only. There is in addition about 20 billion tons of inferior coal which cannot find a market under existing conditions. It is impure, and for that reason it is not included in the aggregate of merchantable coal, but it has a prospective future value.

In 1873 the annual coal output of the State was 672,000 tons. In 1907 it was 48,091,583 tons, and the total quantity taken from the ground from 1873 to 1907 was 428,000,000 tons. During the past five years the annual increase has exceeded four million tons. If that rate of increase continues until 1920 the yearly output of the State will be 100,000,000 tons. How long the present rate will continue, and whether it will increase or decrease, cannot be predicted with certainty. There is no reason to expect the coal mining industry of the State to lag. Development will certainly keep pace with available market, and the first check may reasonably be expected to come when the carrying capacity of present railroads traversing the coal region of the State has been reached.

West Virginia may, with small likelihood of meeting disappointment, count on the State's having coal as long as it exists in considerable quantities anywhere in the country. When a coal shortage begins to be felt, West Virginia will not be the first place to feel it.

The comfort in that assurance is materially lessened, however, in view of the fact that a falling off of supply is already imminent in some sections of the country. One by one the coal regions will enter the period of declining supply until the whole country feels it. The alarm has been sounded, but the actual danger is yet a considerable way off. It has, nevertheless, been brought a good deal nearer than it was once thought to be, not much by the diminishing of the actual quantity in the earth, as in the discovery, first that the quantity had been overestimated, and second, that a large portion of the actual quantity seems in danger of being lost through wasteful methods.

The situation in West Virginia is, in a measure, the situation the country over. Actual surveys have been made of the State's coal measures, and it has been found that the total amount of coal is hardly more than half of what it was once supposed to be. A broad belt across the State from North to South, in what was thought to be the center of the field, has been proved, by actual borings, to have little coal. Thus approximately fifty per cent of what we were thought to have, vanished when a knowledge of conditions was attained, and the field now embraces only about two-fifths of the State.

It could scarcely be maintained that the State has lost what it never had, but there is no question that it is in a good way to lose much that it has. The first of the losses on a large scale which is threatened concerns the inferior coal. In the first place, one-fourth of the total quantity in the earth, or 20 billion tons, is low grade, consisting of bony coal, and streaks high in ash, and other impurities. Miners reject this, because no sale exists for it. If taken from the ground at all, it is dumped with the waste. Should present methods continue until the seams are exhausted, this inferior coal would be all lost. Yet, it could be made valuable. If manufactured into gas, and used in gas engines, it produces more power, ton for ton, than our very best coal when used in a steam engine. Operators cannot sell it along with the better grades, so they throw it aside or leave it in the mines where it can never be recovered.

A second source of loss concerns merchantable coal, temporarily left as pillars and colums to support the roof of the mine. Sometimes nearly half of the coal is thus left. The purpose is to take it out later, but frequently the roof falls, and the pillars are buried beyond recovery.

A third loss of large amount is due to the manner of mining. Thick seams are frequently separated in two parts by a layer of slate. If this layer does not exceed a foot in diameter it is usually taken out, and the coal both above and below it is mined. But if the seam of stone is thicker, it is frequently left in, and coal beneath it, or above as the case may be, is left also, and cannot subsequently be recovered, except at great expense.

Another waste which will be enormous in some fields if a change in method is not brought about, is caused by mining a lower seam first. There may be several seams, one above the other, with rock formations of various thicknesses between. One of the lower seams may be better than the others, and it is worked first. The removal of the support breaks the rock strata and the coal seams above, and they may become so badly dislocated that the coal cannot be taken out, and it must be added to the waste.

The extraction of the deepest seams threatens serious results when the time comes to take out the overlying coal. Gas from the diggings below will rise through crevices and permeate the overlying seams and may render it impossible for miners to work there.

In some parts of West Virginia another source of danger exists. Hundreds of abandoned borings, in the track of oil and gas operators, penetrate the coal beds. Gas is present in many of these holes, and when miners tap them, explosions or asphyxiation will be probable. No chart shows the location of many of these abandoned wells, and a serious state of affairs will result when mining operations reach them.

The total of the losses enumerated amounts to from 40 to 70 per cent of the actual cost deposits. The remainder is what is being drawn upon for the 48 million tons a year, present output in West Virginia, and the prospective output of 100 million tons twelve years hence. How long will it hold out

The time that the West Virginia coal will last may be lengthened from two to three fold by stopping the waste and using the whole product. It is easier, however, to say what ought to be done than to find a way to do it. Human statutes cannot override nature's laws, and the rule of supply and demand comes nearly being a natural law. If there is no demand for the bony coal, it will not be easy to sell it. There is no demand now. The owner who is obliged to take it out along with the merchantable coal cannot be compelled to put it on a market which will not take it, nor can a buyer be forced to take what he does not want. It is apparent, therefore, that a point is soon reached which no law can go beyond without becoming an instrument of tyranny and confiscation.

The remedy for the waste of unsalable coal does not lie in the direction of new laws. It must rest on a broader foundation, the corner-stone of which consists in finding a use for the commodity. After that, if laws seem to be needed to faciliate putting it to use, they may, with justice, be enacted. But a way must first be found to give a commercial, not a theoretical, value to the impure coal which is associated with the good grades, and must be taken out with it, or abandoned in the mines.

In another part of this report, which deals with the manufacturing possibilities in West Virginia, the value of the impure coal when converted into gas is discussed. It would be sufficient to develop one million horsepower and keep it in continuous operation for 2300 years. The waste will end when a market shall be found for the power which may be produced from the coal now thrown away. The remedy should be looked for in that direction. Let boards of trade, commercial bodies, corporations, and individuals give attention to the building of factories which need power, and let the mine owners convert their waste into power. That will solve the problem, and in solving it, the way will be open to the solving of many other problems of conservation. The key to the situation is in finding ways to put to use such resources as are now idle. Make them valuable. Make it worth while for the owners to save them. This is a work of education and investigation. Markets exist within reach of the West Virginia coal fields—by transmitting power by electricity—to take all the power possible of development from coal now going to waste. It is a work belonging to the business men of the State to devise means of selling the power to factories and traction companies that will take it. It might be found practicable to manufacture producer gas from the inferior coal and carry it in pipelines to furnaces and factories many miles distant.

The lessening of waste caused by mining deep coal seams, by which overlying seams are ruined, is a problem somewhat different. In some mining regions—in foreign countries at least—it is customary to support overlying strata, when coal is removed, by packing the vacant space with rock. The expense would be considerable in many cases, but it would save the coal above, and would be profitable in the long run, It would likewise be profitable in the end, though somewhat expensive at the time, to privide supports, where pillars of coal are left now to hold the roof in place. By that means the pillars could be taken out and serious waste prevented. The coal that might be saved is marketable, and the cost of its removal is the prinicpal thing to be considered. It is not a question of finding a place to sell it as in the case of the inferior grades now left in the mine or at its mouth.

The shoving up of the roofs of mines would have good results in saving the surface of the land from cave-ins. This is particularly desirable in agricultural districts where the land is valuable for farming. It is well known that much damage sometimes results from the breaking of the surface of agricultural land by the falling in of galleries and chambers where coal has been taken out. This matter is of no small importance and is worthy of consideration in all plans intended to conserve resources.

The Waste of By-Products in Coke Making.

The old style bee hive coke oven with red flame issuing from its crater-like top is an agent of waste which seems out of place in this day and age. The Texan of a generation ago killed cattle for the hides, and left the horns and carcasses on the plains. The western hunter fifty years ago slaughtered buffaloes for their robes, and made no use of the rest of the animal. It is said that in parts of Alaska deer are killed by thousands for their skins alone. Bird hunters have depopulated many tropical forests to procure wings or crests. In all these instances there was extravagance and waste. It was long looked upon as nobody's business in particular. The public generally gave little thought to the Texas cattle, Montana buffaloes, Alaska deer, and Carribean birds.

The old way of making coke is little less destructive than the old way of hunting game. The waste is often the largest part. If West Virginia's smoke were in Germany, the Germans would make enough money out of it to maintain their standing army. There are 23 pounds of nitrogen in an average ton of West Virginia coal.

Something near 5,700,000 tons of coal are made into coke by the 18,855 coke ovens in West Virginia. The coke is worth about $6,856,000. The nitrogen, which is useful in making fertilizers, is worth from 20 to 25 cents per pound—say 20 cents. In making the coke of one year (year ending June 30, 1906) the value of the nitrogen that went into the air was $26,221,771. Yet the nitrogen is only one of the wastes.

Nitrogen is absolutely necessary for the growth of plants, and the supply is failing rapidly. It is abundant in the air, but very hard to extract, and fix in a form available for fertilizers. The world is being ransacked for it, and science is doing its utmost to find new sources; for if the supply runs out, the bread crops will fail. Four sources of nitrogen are available: Vegetable remains, slaughter house by-products, natural nitrate deposits, and ammonium compounds from coal and gas retorts and coke ovens. The supply is running short from every source, except from coal, and that seems capable of enormous development. That from coke ovens alone need be considered in this connection. In 1905 the gas works and coke ovens of the world produced as by-products 557,000 tons of ammonium sulphate, of which 80 per cent was used in the manufacture of fertilizers. The United States is credited with only 14 per cent of the total. West Virginia coke makers lost a great deal more than all the by-product ovens of the western hemisphere saved of this valuable commodity. The annual waste of nitrogen by coke ovens in this State is more than the equivalent of 280,000 tons of nitrate of soda from Chile.

This waste is not necessary. It could be prevented by the substitution of the by-product oven for the old style bee-hive arrangement.

A little figuring will show what the State will lose in nitrogen if present methods of coke making should go on to the end of the coal supply. West Virginia has over 60 billion tons of coal yet unmined. At the present rate of mining and coke making, about one-sixth of the coal taken from the mines is made into coke. If this continues while the coal resources last, the total used for coke will be 10 billion tons. Each ton has 23 pounds of nitrogen, worth about $4.60. The nitrogen in 10 billion tons will be worth 46 billion dollars, or 20 million dollars a year, for 2300 years. This is the waste now threatened in one coke by-product alone in West Virginia. But it is easy to save it, and it will without question be saved.

Why not begin to figure on something practical for that waste? Why not see if a plan cannot be evolved—not all at once, but in time—to build roads, found and endow schools, construct bridges, pave streets, and carry on public works in West Virginia, by diverting the columns of smoke from the coke ovens into the treasury. The great Ural highway in Russia and Siberia cost $10,000 a mile, and is 900 miles long. The nitrogen from coke smoke, now totally lost in West Virginia's mining regions, would build that road in five and a half months. Andrew Carnegie has set apart $10,000,000 for a great University. Six months of waste from one of the State's resources alone would provide a like sum; and what a great school it would build. The demand for better roads in West Virginia is universal, and no less universal is the excuse that funds for their building cannot be had. Yet twenty million dollars a year in one item is lost. How many years would it take, if that resource were utilized, to gridiron every county in the State with pikes like Appian and Napoleon built? They save the by-products of coke ovens in Germany. They do not seem to find it a marvelously hard thing to do there.

The demand for commercial fertilizers outruns the supply, and nitrogen is an indispensible and the most costly element in them. The United States is paying over $100,000,000 a year for fertilizers, and would buy more if it could be had. The Chilean Government in South America derives a revenue of $21,000,000 yearly from its share of the sale of this commodity, from natural beds of nitrate of soda which will be exhausted in 35 years, and that will practically end the world's natural deposits of nitrate. Secretary James Wilson says that the vast areas of agricultural land in the Mississippi valley cannot be given fertilizers because the supply is too short to go round. It is nitrogen that is short. All else is plentiful. Yet, more of that valuable element exists in West Virginia coal than Chile ever had—ten, yes a hundred times more. Every ton of coal passing through the oven gives to the air—lost forever—$4.60 worth of this nitrogen, and about six million tons of coal go to the ovens yearly. And this, too, while tax hunters rake the state in efforts to discover something that is escaping taxes. It is like the gambler Parr who would throw thousands away at the gaming table, and the next morning haggle with a huxter over the price of a five cent bunch of radishes.

The nitrogen is not the only by-product in coke making. The gas that now gos into the air is valuable for heating purposes, and can easily be collected and made available. There are other products which, with various combinations, enter into the manufacture of coloring materials, and useful commodities of many kinds. So many and so valuable in fact are the by-products now lost in coke making that they may be worth more than the coke. It is a repetition of the economy of the Texans who killed cattle for the hides. In Germany where they have learned to save, it is said that coke is looked upon as a by-product, the other materials being worth more. But in West Virginia the other materials are burned, and the coke only is saved. It is certainly true that half the value of the coal is lost in the making of coke by present methods.

This waste is not excusable on the ground that there is no market for what is wasted. It is not a thing like Bony coal, which must wait until a market has been created for it. The market is ready, but not usually in the immediate vicinity of the coke plants.

A by-product oven costs four or five times as much as the common bee hive oven. That is one of the reasons why it has not come more extensively into use. Another reason is that some of the by-products could not be conveniently carried to market. For example, gas is a by-product, and a demand for it does not exist in remote mining regions where coke plants are frequently located. The substitution of by-product ovens for the old kind would require important changes in coke manufacture before the new methody would pay. It would be necessary to build the plants near the market for by-products, particularly the gas. Instead of coke ovens near the mines, and the shipping of the coke to its market, the coal would be shipped, and the coke would be made in the vicinity of its own market, and of that for the manufactured gas.

It might be argued that so radical a change in the manner of coke making would not be to the interest of West Virginia; that it might result in the transfer of manufacturing plants beyond the State. That would be true to some extent, but there would be offsets which would more than make up any loss on that ground. Coke makers would not ship coal beyond the state to reach by-product market if they could find one nearer. The result would probably be the development of manufactures within the state. It is not unlikely that one of the first good results would be the building of glass factories, and other furnace-using plants, to get the benefit of the gas from coke works. A broader survey of the question will, at least, show general advantages. The saving of valuable products, heretofore going to waste must result in benefits which would reach far and wide. It would be better in the end for all concerned. Temporary inconvenience and expense would be offset by permanent gain.

Some large and progressive companies have abandoned coke making by the old method, and are building no more bee hive ovens. Their example will without doubt influence others to do likewise. Public sentiment, when once the question is understood, will not look with favor upon the system which wastes half a resource to get the other half, when the waste is unnecessary. The old wasteful system ought to end, after a reasonable time is given to all concerned to close up deals and transactions begun under old conditions. The people of West Virginia have rights in the matter, and it is for them to say that preventable waste of a great resource shall not continue indefinitely. This Commission is of the opinion that five years' notice is enough to give the builders of bee hive ovens, and that no more should be constructed after the end of that period. Only by-product ovens ought to be built after that time, but it would probably be unfair to forbid the making of coke in bee hive ovens which are now in commission, or which may be placed in commission before the expiration of the five year period. They might properly be used as long as they may last. The change from the old to the new kind would be gradual. Investors would not be hindered in consummating deals now under way, or seriously contemplated. Companies which have taken preliminary steps to build bee hive ovens would have plenty of time to finish them before the expiration of five years. Although such plants would continue the enormous waste for a time, the end of it would be in sight.

West Virginia's Natural Gas.

In nature's economy and bounty she gave to West Virginia an enormous quantity of the best fuel that cosmic chemistry has produced. Natural gas is ideal. When coal or wood burns, it is first converted into gas, and it is really the gas which burns. But no such conversion is needed with natural gas. It comes from the earth already prepared. Deep in the earth's laboratory, shut in by thick layers of rock, the slow decay of vegetable matter went on for thousands of years—and countless ages ago—producing the heat-giving and light-making substance, which was stored beneath the anticlines where the rocks were folded in arches and it remained there until the drills tapped the sub-crustal tanks and let it out.

What the total amount of natural gas was in West Virginia when boring began some fifty years ago can not be estimated. No one can guess how much is left. Some idea of the quantity used may be formed; and a very wide and random guess can be risked as to the amount blown into the air and wasted; but whenever an attempt is made to express quantities in figures, the vagueness of the data on which estimates must be made discourages the attempt.

No apology need be made for the gas used. Some of it was not handled economically. It was extravagant to run steam engines by the forcing of gas into the cylinders in place of steam. The using of thousands of feet of gas in flambeau lamps, in towns, along highways, and on farms, when tens of feet properly burned would have made more light, was wasteful; and it added to the wastefulness to burn the lamps day as well as night for years at a stretch. But still, the gas was put to some sort of use, and though the waste was very great it was infinitesimal compared with what occurred in places where no pretense was made at using the gas, but it was blown into the air as from the craters of volcanoes.

The greatest loss was from unplugged wells. The oil developers were not looking for gas, but they found it oftener than they found oil. They let it escape while collecting the oil from producing wells; and from wells which gave no oil, the gas was permitted to blow with no thought of its value. Some wells poured out millions of feet daily, and they were active many years.

The total waste in West Virginia probably has exceeded the State's entire coal production—nearly 500 million tons—counting that it takes 30,000 feet of gas to equal one ton of coal. This is 15,000,000,000,000 cubic feet—a row of figures which cannot possibly convey to the mind an adequate idea of the vast quantity indicated. Picture it another way. Imagine freight cars loaded with 45 tons of coal each following one another down an incline, one minute apart, and pouring their coal into an abyss from which it could never be recovered. The waste of one day would cause the people to call a stop, because they could see the coal going, and they could understand what it meant. But they did not see the gas going, and they let it go without protest. Yet, the waste of gas has equaled what that waste of coal would be, not for one day only, at a car a minute, not for one week only, or a month, for not until the incessant procession of 45 ton cars had plunged into the abyss minute by minute, day and night, for twenty years would the loss come up to that of natural gas in West Virginia through the negligence of man.

Why was it permitted? Simply because it was nobody's business to stop it, and it was somebody's business not to stop it. The waste was principally due to oil operators who let the gas escape, because it would cost something to plug the wells. Fifteen hundred million dollars worth of the best fuel in the world (at 10 cents a thousand cubic feet) has been lost forever in West Virginia because it was nobody's business to save it.

Whose gas was it? The oil operators perhaps supposed it was theirs, because they held the leases, but it was not theirs. They might have used it, but had no right to squander it. The public has some rights in matters like that. The natural resources do not belong to individuals or companies, except to a limited extent. Their right to use does not carry with it license to destory. The heritage that has been squandered—fifteen hundred dollars for every man, woman, and child in West Virginia—belonged to the people of this generation and those which are to follow.

It is not profitable to refer to past losses that are beyond recovery, unless something practical may result. The millions of dollars blown into the air from unplugged wells is not a concern so vital now as is the question of what is to be done to check the waste still going on. The past history calls for discussion only. The present and future demand action.

The waste of natural gas continues. It is probably not so great as formerly because the supply in the earth seems to be diminishing. The better price and greater demand for it also has something to do with saving it. But the waste is still enormous, from unplugged wells, from wells from which both oil and gas flow, from leaky pipes, and otherwise. The total waste of gas in West Virginia has now fallen to probably the equivalent of 10,000 tons of coal a day.

What is going to be done about it? Shall it go on, or shall it stop? It will not stop itself, because it is still somebody's business to see that it does not stop. It will cost something to plug wells and to provide for saving the gas from others which produce oil also. It is cheaper for those who operate the oil wells to let the gas blow; but is it cheaper for the people of West Virginia to permit it to be done?

Dr. I. C. White, State Geologist, who is better acquainted with this subject than any other person, said last May—speaking of this very subject before the President of the United States and the Governors of the States, at the White House in Washington:

"For ten long years your speaker has appealed in his official capacity as State Geologist, to the legislature of West Virginia to put some check upon this frightful waste of our State's most valuable resource * * * * * * but some unseen power, greater than Governors or Legislatures, has so far thwarted and palsied every effort to save to the State and to the nation this priceless heritage of fuel."

If the time has come when a law that ought to pass can not pass in West Virginia because there is an "unseen power" that says no, it is a serious matter. If that condition exists, it is time to "render unto Caesar the things which are Caesar's."

It has been contended, and may be again contended, that it is now too late to take measures to save the gas. Conditionas do not warrant that contention. There is less than there once was by some thousands of billions of cubic feet, but there is much yet in the ground.. No one can tell how much, but while there is still pressure enough behind it to drive 250,000,000 feet of it into the air daily, there is evidently a good deal of gas still in store.

This seems to be a case where a law that means business will do good. In some of the problems of coal-saving it is hard to see how a statute can produce a direct result, but it is different with the gas waste. Wells can be plugged and leaks of pipe lines stopped. They have found a way to do it in Indiana. It was contended in that state that it could not be done, but it was done. The law was attacked in all the courts, but it stood the test. This Commission, therefore, most urgently recommends that the West Virginia legislature enact what is known as the "Indiana Law" which has for its purpose the checking of waste of natural gas.

Lamp Black Factories.

There are a number of lamp black factories in West Virginia which use natural gas as raw material. It is well known that a small part of the carbon in the gas is utilized in the manufacture and that perhaps 90 per cent of it is wasted. This seems a great waste for a small return. It is worse than the old style coke oven were the loss is probably fifty per cent.

This Commission has been informed by competent chemists that no process is known whereby the waste in making lamp black from natural gas can be lessened, and it is not prepared to make any specific recommendation in this matter, but it is impressed with the extent of the waste compared with the product saved. Do the people of West Virginia consider it a good business practice to waste 90 per cent of a resource to utilize ten per cent? The matter should be viewed from the standpoint of the public—the real owners of the resource—and not alone from the viewpoint of the manufacturer who shows by his actions that he considers the waste justified by the returns which come from the small part which he saves. His gas supply is unlimited—while it lasts—and so long as he has plenty he can make money by utilizing ten per cent of it, and wasting the rest. But are the people of West Virginia satisfied that this should continue?

West Virginia's Petroleum Industry.

After the long list of wasted resources in foregoing pages, it is a relief to reach one which has not been squandered. The petroleum industry in this State, as elsewhere, has been well managed. It is an example of what is practicable in developing a great resource and at the same time practicing business economy. The oil men wasted enormous quantities of natural gas, but they did not waste oil.

The custom of criticizing the methods of the great oil companies has become so nearly universal that any commendation runs the risk of being misconstrued by demagogues who never speak of a good quality and never fail to make the most of a bad one. It is a fact, however, that no great enterprise in West Virginia has developed one of the State's resources with more economy or along safer lines than its oil developers. Had other resources been handled in that manner, products worth hundreds of millions of dollars would have been used, or saved for future use, which have gone forever without doing good in any way.

Condemnation was loud—in certain quarters at least—a few years ago, because, as was said, "West Virginia oil built the Chicago University"—meaning that money from oil operations had been spent that way. It would be more pleasing to the people of the State of course, if the money made from this State's products were spent in West Virginia; but there is another side to the question which appears to have been overlooked. The millions given to found an educational institution at Chicago represented no more than a small part of the savings made possible by utilizing oil by-products— the odds and ends scraped together in that one branch of development, and which other so-called developers would have thrown away. If some one had possessed the business ability to scrape up this State's forest waste—merely what has gone to the waste heap—he could have built ten Chicago Universities, and used nothing in doing so except matrial that has rotted in the woods or gone up in smoke. The savings would have done it. The coal waste—that which has been thrown away in this State—would build ten more such universities. The waste in smoke from coke ovens, which nobody thinks worth saving, is enough to found such a university every year. The State's unused water power would do as much. The natural gas waste up to the present time would build a hundred universities and endow them.

The oil companies grew wealthy because they saved. Although engaged in vast enterprises, they did not "despise the day of small things." The Standard Oil Company's exhibit at the Jamestown Fair was worth serious study by every West Virginian who has any part in the development of natural resources. It was an exhibit showing the by-products from petroleum. It looked like a drug store with its jars, bottles and other articles. Each was a commodity, useful and valuable in the every day life of the people—wax, oils, vasaline, soap,. paints, dyes—dozens and scores of things, nearly everyone of which was a by-product. Under present forest management, coal workings, gas handling, coke making, and so forth, in West Virginia, all of them would have gone into the rubbish pile or into the air.

Demagogues, who have worked overtime in holding up the great oil companies as examples of business heartlessness and political depravity, would do well to rest from their labors long enough to make a serious study of the manufacturing methods of those companies, their ability to save and use, and their masterly economy of resources. Such a study would teach many useful and needed lessons in the science of developing without wasting.

PART III.

THE PERPETUAL RESOURCES.

The Forest Lands.

The state of West Virginia contains 15,859,200 acres. When white men first came into the state it was all forest except a few cliffs and rocky peaks, and two or three old fields where Indians had probably cultivated corn. The story of the clearing of the early farms by "deadening" and "logrolling" is so well known that no further mention of it is necessary. The timber in the valleys and on the most fertile lands was first to go, because settlers chose the best places first. The richest land produces the best timber just as it grows the biggest corn. With the clearing of the valleys, therefore, the choicest timber was destroyed. The oaks, walnuts, poplars, maples, ashes, hickories, and other timbers that grew on the deep soil of the river bottoms surpassed the mountain forests, not in acres, but in size of the trees, and in most cases in quality also. The pioneer's ax leveled and burnt them. It was the most sensible thing he could do at the time. He needed the land and no one wanted the timber. When his children were ready for the work of life in about the only avenue of usefulness open to them, cultivation of the soil, they cut more timber and cleared additional acres. Thus the open spaces gradually widened and increased in number, and the forests decreased in a corresponding degree.

Experience from the days of the pioneers till the present has taught that only one acre in three, taken the state over, is suited to agriculture. Not one acre in four has been cleared for farming purposes to the present time. Fully two thirds of the state, therefore, and more than ten million acres, have never known the plow, and probably eight million acres, or approximately half the state, will never be used for farming purposes. It is so rough or steep that field crops cannot be successfully grown. This land constitutes the natural timber region of West Virginia. Trees of some kind are growing, or may be made to grow, and did grow in the past, on practically every acre of it. It is fortunate for the state that its climate and soils are such that every part of it will produce something valuable. The level lands and the moderately steep, if not too stony, are adapted to agriculture. The rest is suited to timber growing or grazing.

How well the whole state is adapted to forest is apparent from the fact that though in area it is less than one-two hundredth part of North America, above the Gulf of Mexico, yet it produces more than one fifth of the tree species. It has more, in proportion to its size, than any other state or province of America. Peculiar and favorable geographic position render this possible. It is at the meeting of the climates, so to speak. The highest mountains are the home of the Canadian flora which has crept southward along the cold summits. Its eastern slope is suited to the trees of the Atlantic seaboard. The western valleys contain trees which reach their full development in the West and Southwest. Several Southern woods attain their Northern limit in West Virginia.

So great a variety of woods has given the state exceptional value as a timber producer, and this value will increase when the time comes for maintaining forests and growing timber by modern methods.

Of the ten million acres or more in West Virginia classed as woodland, a large part is not growing much timber now. In its present condition it is a discouraging asset. No one considers it of much value. This unproductive area consists of bare and sterile mountain tops and ridges from which men and fire have removed the primeval growth; and of lower hills and flats frequently classed as "redbrush," from which the good timber was long ago cut. Much of this land has been so often burned that the soil has lost its fertility. The sprout growth seems never to increase in size. The gnarled and scrubby bushes stand as perpetual discouragments to those who own the land.

Forest Statistics.

In its wild and primeval state, when the whole area of West Virginia was in woods, the total quantity of timber was probably 150 billion feet, board measure. The forests had reached a state of equilibrium. The growth was neither increasing nor diminishing but was at a standstill. The young growth coming on and the old trees dying and falling, balanced each other. Such is the condition in old, mature forests where nothing disturbs the balance of forces. Only in the most general way can estimates from available data be made, but it is within reason that the quantity of timber grown in the state since it ceased to be an unbroked wilderness has been 150 billion feet. This added to the 150 billion feet in existence when the pioneers first came, would make a total of 300 billion feet in the West Virginia forests since civilized man first saw them. What has become of this timber?

The table which follows shows this only approximately. From the nature of the case accurate calculation is impossible. Only one of the items, the cut since 1879, is from the records:

Items.	*Feet Board Measure.*
Timber used for fencerails in 120 years	4,275,000,000
Farm timber other than fencing, prior to 1880	1,000,000,000
Construction of wooden houses in towns prior to 1880	500,000,000
Fuel in 120 years	10,000,000,000
Quantity now in forests	30,000,000,000
Lumber cut since 1879	15,419,500,000
Quantity wasted	238,805,500,000
Total	300,000,000,000

Not much timber was cut in the state before 1880 except what the people used at home. The cut in each of the following years is shown:

Year.	*Feet Board Measure.*
1880	180,120,000
1890	301,958,000
1900	778,051,000
1907	1,395,975,000

West Virginia has about one-sixtieth part of all the timber in the United States. In 1907 the lumber output of the United States was 40,949,954,000 feet of lumber, 3,663,602,000 lath, 11,256,154,000 shingles with enough cross-ties, poles, posts fuel and other forest products to make a total of 100 billion feet. If all of this should be drawn from West Virginia the state would be stripped in less than six months. It is estimated that at the present rate of use, the forests of the whole country will be in advanced state of depletion within twenty years. If the 1907 rate of cutting is maintained in West Virginia the state's timber will be gone in 22 years. This takes no account of loss that may be caused by forest fires. If the experience of 1908 is to be repeated, the period of lumbering in this state will be considerably shortened.

The statement that the time is near when the timber of the state or of the whole country will be completely exhausted, should not be taken literally. The situation is not so desperate as that. As wooded areas decrease, and distance from market increases the difficulties of logging, the output will fall off. The people will have to get along with less, and that will make remnants hold out longer. There is, too, a fringe of silver on the dark cloud of the approaching timber famine. The danger has been seen, and heroic measures are being taken to ward off part of the effect. The Forest Service of the United States is doing all it can to stop waste and increase growth in the West where the Government's timber lands are located. Several of the states, and some of the largest railroad companies are planting timber, checking waste, and controlling fires. Although wood will become scarcer and higher in price than it ever has been in this country, it is believed that the energetic measures undertaken in different quarters will result in partially averting the calamity which otherwise would produce disastrous consequences in a very few years.

Destruction by Fire.

Fire is the forests worst enemy. It has destroyed billions of feet of timber in West Virginia. The loss has increased as forests have decreased, and for apparent reasons. There seems to have been little loss in the early years of settlement. Travelers and writers of that time who were familiar with the country seldom mention fire; and there is little evidence to be found in the condition of the woods to show that fires did much damage. Old "burns"—that means tracts of timber killed by fire—were few and small fifty years ago. Early chronicles occasionally speak of tracts on which timber was thrown by wind, but they are so uniformly silent as to fire that the conclusion is logical that forest conflagrations were rare. It is natural that they should be, for settlements were few and far apart, and fires seldom start except near improvements. Lightning has been known to start fire, but not often in a climate like West Virginia. It is highly propably that the almost unbroken woods of former times were damper than the fragmentary forests of today, and fire would burn more slowly then. It is not know to a certainty that rain was more abundant, but it is probable that between a more copious precipitation and the unbroken shade which hindered the drying process, the average dampness of the woods was much more pronounced than at present.

The wholesale destruction by fire of the softwood forests (cone-bearing trees) began about the time of the civil war. The largest single burn is that which extends along the summit and sides of the Alleghany mountain, nearly unbroken, from the head of the Greenbrier river through Pendleton, Randolph, Grant and Tucker counties. That opening was begun by a fire which spread from the camp of confederate scouts on the Roaring Plains, in Randolph county. It has been enlarging ever since. Many destructive and spectacular conflagrations have occurred in the region, the most formidable being that which swept the eastern side of the Alleghany mountain on the headwaters of Big Creek, in Pendleton county. Eye witnesses have stated that the flames overtopped the tallest pines and advanced ten miles an hour.

Apparently, the pine forests have suffered most from fire, but in reality the damage to the hardwoods (broad-leaf trees) has been more in the aggregate, because covering much more country. The undergrowth is often destroyed, and this kills the forest which would be productive a century hence. A bad pine-woods fire may kill old and young, all at once, while in a hardwood forest one must look forward a hundred years to see the full injury—perhaps a thousand years would not be time enough to show it all where the humus of the soil has been burned out.

The manner in which fire destroys the foundation on which a forest grows is apparent for an examination of changes in the soil on the Alleghany summit and neighboring ranges where the woods have ceased to exist, and that one case is typical of many, and in a lesser degree of all. Over much of that territory the foundation on which the forest stood was a mass of broken and split rocks, and beneath that the soild rock. Trees had found an anchorage for their roots, and for centuries the decaying needles and leaves had been falling into and filling the cavities among the stones. Mosses and lichens had grown and decayed. Each season added a little to the soil, and the accumulation of organic substances, with the mat of living moss, covered the underlying rocks to a depth of from one to three feet. This mass of vegetable matter, with the fragments of broken rocks beneath, was a soil in process of formation—a new soil just coming into existence. Had the process gone on a sufficient length of time, a deep, agricultural soil would probably have been the result, though ages might be required to do the work. The opinion has been expressed by Chamberlain that ten thousand years may be required to form one foot of mineral soil. A thing so valuable, and so slow in making, ought not be carelessly destroyed.

In the case of the mountain tracts alluded to, the process of soil-building was cut short by fire. The work of centuries was undone in a few days, and the moss and vegetable matter covering the rocks were consumed. The trees quickly died and were thrown by the wind, becoming food for future fires which completed the destruction. What little mineral soil there was, was washed into deep cavities by rain, and large tracts became treeless, and almost without soil. That is their condition now. Reforestation will be slow and difficult, for the whole process of soil building must be gone over again in some places.

Fortunately, the area of excessive denudation is small in comparison with the whole state. It lies chiefly on the high, stony mountains. But fires have done immense damage over wide regions lower down. The hardwoods (the broad-leaf trees) occupy the principal part of the state, and fires run through them at intervals. There is usually a deep mineral soil, and fire does not get down to the rock as it often does on the mountain tops. But it injures the soil. The vegetable matter, which furnishes plant food, is burned out. The seedlings and sprouts are killed. The mature trees may seem to escape unharmed, but they seldom do. Insects and fungi enter through the injured bark, and decay begins. A profuse crop of sprouts usually succeeds a fire among hardwoods, and the sprouts might become trees if let alone; but other fires follow. At length the mature timber disappears—by natural decay or lumber operations—and a jungle of worthless scrub brush is apt to be all that remains.

Such is a familiar sight in many parts of West Virginia. It is due to repeated fires which not only kill the young growth but burn out the soil's fertility.

Suppression of Forest Fires.

The first step in a state forest policy is the lessening of the loss from fire—saving the timber, the young growth, the soil, and reducing floods and mitigating droughts. Other things must be done, too, but the fire problem is the greatest. Can fires be controlled in the West Virginia woods?

They cannot be stopped entirely. Even the best regulated cities sometimes have conflagrations; so will the best-guarded forest lands. But the problem is not so difficult as many suppose. Nearly all fires might be extinguished before they do much damage, if taken in time. The time to take them is before they begin. Be ready, and attack them while small. Prevent them as far as possible by wise law, well executed. That is more than half the battle. The other half consists in being ready at the right time and place, prepared for emergencies.

The United States forest fire fighters have given practical proof of what is possible. They are the guards and rangers in the National Forests, and are the best trained fighters in the world, in their peculiar work. The system which they employ so effectively could be used, with slight modification, anywhere. The National Forest contains 168 million acres—more than ten times the area of West Virginia. All kinds of wild land are included, the dense wilderness, the almost impenetratable brushwood, open forest, stony mountains, including the highest and roughest in the United States, glades and open space with grass, and all intermediate sorts. Some of it lies under or near perpetual snow, other on the borders of sandy deserts. The land does not all lie in one body, but is scattered in patches over a million square miles, all west of the Mississippi river. When the United States undertook to protect the timber on this land, fires had been burning with little or no restraint every season for many years, with loss almost incalculable.

The season of 1908 was dry all over the country. No very large region escaped. Fire is no respector of Government property. A comparison of results in National Forests and elsewhere shows what organization and forsight can do, even under the most trying conditions. The fire loss in the entire National Forests—ten times as large as this State—did not much exceed, if it exceeded at all, the loss in two West Virginia counties, Randolph and Tucker; while the extra expense the Government was put to in fighting fire did not equal the loss in tan-bark alone which a single company is reported to have suffered from fire on the headwaters of Cheat river.

This reference to the Forest Service's success in keeping fires down is given to show that practical results are possible. Some of the states, notably, New York, Pennsylvania and California, have organizations which have met with almost equal success. The Government does not employ a large force in proportion to the area covered. The actual patrolling force for the season of 1908, after deducting men who gave their attention to other matters, would be less than one man to a county in West Virginia. When a fire started, a large force would be quickly concentrated at the point of danger.

The Act which this Commission recommends for West Virginia takes the magisterial district as the basis of the fire-fighting organization, and the constables as ex-officio fire marshals. This localizes the work as much as possible; and with proper organization under a state forester it ought to be an efficient and inexpensive force.

Forest Fire Statistics for West Virginia.

During the fall of 1908 more complete data regarding forest fires in the State were compiled than ever before. It was done by the United States Forest Service as a part of the general work along that line all over the country. Though more complete than any similar statistics for West Virginia, there is reason to believe that in many particulars all the facts were not ascertained.

The first serious fire occurred August 28, and from that time there was no cessation for three months. Every county in the state was visited by fire, but in some instances only a few acres were burned. The total number of fires reported was 710; the number of men called out to fight was 5821; the cost to the county treasuries, so far as reported, was $646; the expense incurred in fire fighting by individuals and companies was $89,100; the area burned was 1,703,850 acres; the standing timber burned was 943,515,000 feet, board measure, worth $2,903,500. The lumber tanbark, and improvements burned were valued at $490,175; the injury to the undergrowth and soil was placed at $1,703,850, and the loss from forest fires in the State made the grand total of $5,097,825 More than one-tenth of the whole surface of the state was burned over, and one-fifth of the forest area. Three per cent of the estimated standing timber in West Virginia was destroyed, including the small as well as the large; and the amount burned was two-thirds as much as the cut of all the mills in the State in 1907.

As to the origin of the fires, 71 per cent were from locomotives, 20 per cent from sawmills and campers, 3 per cent set to improve the range for live stock, 2 per cent incendiary, and 4 per cent from other causes.

The Forests Influence over floods and droughts.

Forests exercise a considerable influence over the behavior of rivers. This influence is not the same in all climates and countries. Each river system must be studied by itself, for deduction under one set of conditions may not hold true under another. Generally speaking, a woodland soil absorbs more water than naked ground. The decaying leaves, the roots and stems, and the more porous nature of the upper layers of a forest soil, take up the rain and melting snow, and hold it for a time, permitting it to filter away slowly and enter the streams gradually. Sudden rushes of water down steep slopes after a rain are thus hindered, and the streams rise more slowly, flow more regularly, and seldom reach excessively low stages. When the same has been laid bare and packed by its own weight and under the unobstructed beating of rain drops, its surface hardens, its porosity is lessened, and it sheds water like a roof. The streams catch it quickly, and floods follow. That is the difference between a forested and a treeless region. A country well cultivated, and producing farm crops, may have a soil almost or quite as affective as a woodland soil in preventing storm water from flowing too quickly to the streams. The dangerous region is the one with steep, bare slopes. West Virginia mountains would, if denuded, be a constant menace to all the lower valleys. Floods surpassing everything known in this region heretofore would be sure to follow. On the other hand, streams would speedily become dry after the rains had ceased.

Public opinion has long held that the floods are increasing in number, not only in West Virginia but in other regions where rapid deforestation has been going on, but only recently were figures compiled showing just what is taking place in this State. Records of river stages and rainfall have been kept daily during many years, at numerous points, by the United States Geological Survey, the War Department, and the Weather Bureau. A compilation of results shows a very disquieting state of affairs in West Virginia. Floods in the Ohio at Wheeling have increased 28 per cent in number in 26 years; Potomac floods at Harper's Ferry have increased 36 per cent in 18 years; the Monongahela's floods, at Greensboro, Pa., show an increase of 73 per cent in 24 years; and at Charleston an increase of 83 per cent is shown by the Kanawha in 20 years.

The increase in low water periods, for the same time, follows: Ohio river 39 per cent; Potomac 40 per cent; Monongahela, 36 per cent; the Kanawha about the same as the Monongahela.

The actual quantity of water discharged by the Potomac per year is 8 per cent more now than twelve years ago; and for the Ohio at Wheeling, the quantity is 13 per cent greater.

The average rainfall for the whole State of West Virginia seems to be about 2 1-2 per cent less than it was eight years ago. This does not necessarily imply that the decrease will be permanent or that it will continue. It is well know that rainfall varies greatly. It sometimes increases during a term of years, then declines, and again increases. The cycle of change seems to be about 35 years; but that matter needs additional proof before it should be accepted as settled.

The increase in the total discharge of West Virginia rivers, in spite of diminishing rainfall and a greater fluctuation than formerly in the periods of high and low water, is due solely, so far as available data can be interpreted, to the deforestation of the mountains. There is no reason to doubt that a continuation of the timber cutting and burning will increase the fluctuation of the streams if, indeed, it does not permanently reduce the rainfall which is by no means improbable.

Removal of Soil through Deforestation.

In the discussion of fires it was pointed out that the vegetable substances in the soil may be burned out, and where the soil is largely vegetable in its composition it may be almost entirely consumed, as was the case on the Roaring Plains and other high, stony plateaus of the Alleghanies. The removal of the natural covering may also prove very injurious to deep mineral soils which are proof against the direct attack of fire. When the ground is laid bare on the steep slopes, rains wash the soil away. It is sometimes worn down over its whole surface, as may be seen in old clay-fields on hillsides; or gullies may form, as is often the case where soils are sandy. In either instance the loss is serious. Every rain carries down a load of silt or sand, and the rivers carry it toward the sea or drop it in their own channels where it forms bars, islands, and shoals. In West Virginia the erosion has not yet progressed far, but agencies are at work, and rapid denudation may be looked for in the near future. In the Appalachian region south of Pensylvania it has been estimated that the soil from 100 square miles goes into the river every year, from the naked hills. The soil is gone forever—worse than that. for it is not only lost to agriculture which sorely needs it, but it fills navigable channels which must be dredged at great cost. Much of the hundreds of millions of dollars which the Government has spent dredging rivers has gone to remove silt washed in from fields which ought never to have been cleared, and from deforested mountains.

West Virginia can attack this waste in its infancy. It should be born in mind that every yard of soil that gets into the streams is lost for all time, because—as already noted—it takes ten thousand years for enough rock to decompose to form a foot of soil. The people of West Virginia should profit by the fate of Dalmatia which let its forests be destroyed and its soil washed away. In some districts of that region the wretched people pound rocks into sand with hammers and make little plots of ground for gardens, some of them scarsely longer than bed quilts. Care of woods once abundant would have prevented the irreparable loss in that country, and it will prevent it in West Virginia.

Protective Forests.

Forests are maintaned for two general purposes, one to grow timber and the other to protect the soil and the watercourses. The same woodland can, of course, answer both purposes. In West Virginia certain tracts ought to be kept permanently in woods, whether any revenue shall ever be derived from the timber or not. Soils which wash badly if bare, and are not suited to grass, ought to grow trees. The steep ravines about the sources of creeks and rivers should remain forested, even if in nothing better than laurel. The purpose is to prevent the drying up of fountain springs which feed the streams. Other patches of woods are useful as windbreaks to protect buildings and live stock. Such forests are not maintained primarily for the wood they may grow. In a state forest policy for West Virginia, protective forests should be carefully considered. Every mountain stream should have its share. In most cases the natural wild forest, when properly protected from fire, would be ample.

Timber Growing.

The practical side of forestry consists in growing plenty of good timber. In many European countries timber trees are planted and little wood comes from any other source; but in this country, and especially in West Virginia, the natural forests have supplied practically all the woods used, and they will do so for a long time to come. A well managed tract, where only mature trees are cut, and when fires are kept out, will produce more timber than the wild wilderness. Gradually under improved methods, lumbering will be less destructive, cutting will not go below a certain size, and the small growth will be spared for future use. The prevailing practice in West Virginia has been to slash with no thought of next year, and to leave the tops where they fall, and make the most perfect firetrap that the ingenuity of man could devise, if he would aim at that end alone. That is what so rapidly depleted the West Virginia woods. It has not been so much the timber taken out as the fires which followed.

Owners of land ought to feel that it pays to look ahead. A second growth comes on more rapidly than most people suppose. It is a hand-to-mouth policy that skins a tract and goes on to another. It is not done in some places. The laws forbid it. The Supreme Court of Maine has held that a landowner must not denude his forest, to the injury of others, and when he skins it, he injures all who have a right to air, water, climate, and scenery, although they may not own a foot of land anywhere.

In nearly all parts of West Virginia the natural forest will reproduce itself if given an opportunity. A hardwood forest, when cut, needs little more than protection against fire. A sprout growth will make timber. The softwoods do not sprout, but grow from seeds only. Therefore, when pine, spruce, hemlock, cedar, and fir are cut a few trees should be left for seed, and a new stand will take the place of the old.

The planting of timber for farm purposes might be made to pay well in this State. Posts and poles are becoming scarce, and farmers would do well to plant rough corners and poor ridges in trees for use fifteen or twenty years hence, when prices become high and the demand heavy.

Taxation of Cut-over Lands.

In some states a portion of the tax is rebated on cut-over lands where the owners, acting under an agreement, leave trees below a certain size growing. This is done on the theory that the consequent protection to the soil and the water courses is a public benefit and that the public should share the cost with the owner. In other cases, a part of the tax is remitted for the same reason on land planted with timber and kept in good condition.

This Commission has examined the matter with considerable care, and though it does not recommend that a policy of that kind be entered upon by West Virginia immediately, it appears to be a good thing to do as soon as conditions warrant it.

The Yearly Growth of Forests.

It is of interest to know how much timber West Virginia can grow, year by year, if its forests are properly cared for, and the vacant spaces are put to work as they should be. Take it for granted that 8,000,000 acres in the State will be kept permanently in productive forest. It can be figured out with a fair degree of accuracy how much timber will grow on an acre, and how much the yearly growth will be. The same rule does not hold everywhere. The growth depends on climate soil, kinds of trees, and the care given them. In some of the finest Japanese forests the yearly growth is as much as 80 cubic feet per acre. In some of the neglected and fire-wasted woods of West Virginia it is not one-tenth that much. In the vigorous hardwood forests of this State the annual increment may be as much as fifty or sixty cubic feet, but in choice localities only. The State's 8,000,000 acres, if guarded from fire, and well cared for in all ways, ought to yield twenty-five cubic feet of timber yearly for each acre. The estimate is conservative. That would provide for a yearly harvest, from the whole State, of 1,600,000,000 feet, board measure. At twenty dollars a thousand feet, the gross income from lumber sales would be 32 million dollars a year. That would not be the rake-off of several years' growth at one time, as at present, with nothing for many succeeding years, but it would come in every year, and as time went on the yield would increase rather than diminish.

As stated elsewhere in this report, the cut for the largest year in the State's record, was a little less than 1,400,000,000 feet, board measure. Under forestry methods, 200 million feet a year more than that could be taken from the land, without injuring the productive capacity of a single acre. In other words, the present lumber cut could be exceeded, and not a tree be cut without leaving another vigorous tree to take its place. But to do this, a radical change in methods must take place. Otherwise, there will soon be little timber left in West Virginia.

The State ought to enter upon a definite policy of acquiring permanent title in lands suited to forest purposes. The land so acquired should occupy strategic positions near the sources of streams where it will protect the water courses at the same time it is growing timber. Necessary legislation should be passed to provide for the care of such lands and their management in all necessary ways. A beginning can be made by holding all tracts coming into possession of the State, through nonpayment of taxes or otherwise. If such lands do not lie in localities where they are needed for purposes of forestry, provision might be made for exchanging them for other tracts better suited. If a policy of that kind is once commenced, it will develop as needs increase or as available means may be found. The expansion will be in the right direction provided the beginning is well planned.

Water Resources.

The average annual rainfall in West Virginia, including melted snow, is about 40 inches. The amount is 2,322,295,810,000 cubic feet, enough to fill a reservoir of sixteen square miles and one mile deep. The mass of water is disposed of in two ways. Part of it flows away by the rivers, and part of it evaporates before it reaches the large watercourses. The part which goes out by the rivers is about two-fifths of the whole precipitation, and in a year amounts to a sheet of water 16 inches deep over the entire surface of the State, or approximately 921,842,176,000 cubic feet. The portion which evaporates would equal a sheet of water 24 inches deep over the whole State.

The water which goes off as vapor renders plant growth possible. Part of it is taken in by the roots and after being used by the plant for various purposes, is evaporated through the leaves. But it is the water which gets into the rivers that counts for navigation, waterpower, and other purposes. The theoretical horsepower possible of development from the streams of West Virginia exceeds two million. One half of this should be set aside as not available in practice. In order to utilize the other remaining one million horsepower it would be necessary to develop all the streams, construct reservoirs on the mountain to collect floods, and provide means of maintaining a steady flow all the time. One million horsepower would go a long way toward meeting all the State's needs in that line. The following table shows the amount of power used in West Virginia for the years given:

Year.	*Steam, Horsepower.*	*Water, Horsepower.*	*Total.*
1870	17,176	10,195	27,331
1880	28,456	9,454	37,910
1890	44,680	10,552	55,457
1900	95,595	10,273	108,566

For the purpose of comparison, a similar table for the United States is given:

Year.	*Steam, Horsepower.*	*Water, Horsepower.*	*Total.*
1870	1,215,711	1,130,431	2,346,142
1880	2,185,458	1,225,379	3,410,837
1890	4,662,029	1,263,343	5,954,655
1900	8,742,416	1,727,258	11,300,080

Railroads are not included in these tables. It is important to note that in thirty years, both in West Virginia and in the whole United States, the use of steam increased from 500 to 700 per cent, while the use of water power remained almost the same for the whole time. The building of railroads made coal cheap and plentiful and it was more convenient to use it than to develop waterpower. Besides, in recent years only has it been found practicable to carry power long distances by electricity. Formerly it was necessary to locate the power plant near the place where the power was to be used, and that generally made waterpower unavailable. It is now practicable to transport power long distances by wire, and this fact ought to open the way for development of waterpower in remote and rugged regions which was impossible a few years ago. Power might be profitably carried by electricity from any point in West Virginia to any other point. Water thus used is a resource which can never be exhausted. It cannot be used up so long as rains fall and rivers flow. West Virginia has a very liberal share of this resource. Its money value cannot be estimated except at so much per horsepower. Taking that at $20. a year, the full development would pay six per cent. on a capitalization of $330,000,000.

The impounding of water in enormous reservoirs by building dams across valleys high in the mountains would not be an experiment. Work of a like kind is being carried on in different parts of the country, especially in the West where the water is made available both for irrigation and power. Some of the dams rank with the world's greatest engineering feats, and they make possible the development of resources which have lain idle in all past time. Reservoirs are being built of sufficient capacity to store the entire flow of a river for many months. West Virginia has many excellent sites for storage reservoirs, some being two thousand or three thousand feet in elevation, others lower. The development of this resource must, from the nature of the case, take a long time. Power will be produced faster than it can be used.

The construction of systems of dams in the mountain valleys would serve other useful purposes than development of waterpower. The storing of a large part of the storm water would lessen floods in the lower rivers, and much of the usual damage from high waters might be avoided. Extremely low water might be prevented likewise by gradually draining the stored water into the streams in dry weather. The flow of rivers provided with large reservoirs can be regulated as rivers are which flow from and through lakes.

Vast dams in elevated valleys would answer still another purpose, though the need of it is not quite so urgent. Large sheets of water in the high mountains where boats could sail, and fishermen and hunters would find attractive recreation, would attract people to resorts there, and the business of entertaining them might become highly profitable. In some states and countries large revenue is derived from resorts very much less attractive than West Virginia's mountains might become if their scenic beauty was developed and brought within reach of tourists. This possible resource is not one of sentiment. It might be made the basis of profitable business and yield large income.

It should be borne in mind, however, that dams and reservoirs without forests would not be worth much. The soil on the steep slopes must be kept covered with vegetation or it will wash into the reservoirs and fill them. Again, the importance of speedy action to protect the forests is seen. Almost every proposed development goes back to and depends upon the forests, and unless the woods are cared for, nearly every other resource becomes unavailable.

West Virginia's River Commerce.

The ability of the streams of West Virginia to carry commerce is one of the State's most valuable resources. The road to market is the path to prosperity; and the easier and better the road the greater the prosperity. Wealth locked up is no better than poverty. Free exchange of commodities is the life and blood of business growth and national development.

The United States Government has improved the West Virginia rivers and made them navigable, but the water and the commerce come from this State. It is for that reason to West Virginia's interest to provide water to fill the channels and freight to laden the barges.

The total extent of navigable water in West Virginia is 784 1-2 miles, according to the figures compiled by the National Bureau of Commerce and Labor. A table showing the mileage of each stream follows:

Monongahela	33	miles.
Ohio	285	miles.
Great Kanawha	90	miles.
Little Kanawha	120	miles.
Guyandotte	50	miles.
Big Sandy and Tributaries	170½	miles.
Total	748½	miles.

Some of this mileage can scarcely apply to boats going up as well as down, but is calculated on the ability of the streams to carry rafts or boats in time of medium flood stages. The Monongahela is considered only from Fairmont to the Pennsylvania line; the Big Sandy, its whole length, and the Ohio along the State border.

The Federal Government has spent large sums improving West Virginia rivers or those receiving their principal supply of water from the mountains of West Virginia. The expenditures from 1790 to 1907 have been as follows:

Big Sandy and Tributaries	$1,445,425 32
Guyandotte	22,500 00
Great Kanawha	4,730,108 02
New River	112,000 00
Gauley	15,000 00
Elk	35,000 00
Little Kanawha	488,844 38
Monongahela, its whole length	6,794,827 40
Ohio, its whole length	24,485,261 26
Buckhannon	5,500 00
Cheat	13,000 00
Total	$38,147,466 39

The remarkable point in these figures is that approximately one-twelfth of the money spent by the Government, from 1790 to 1907, for the improvement of the rivers and the harbors of the whole country, has been spent upon rivers depending in whole or in part upon West Virginia for their Water. Cut off or greatly reduce the flow from the West Virginia plateau region and every one of those rivers would immediately feel the effect, and would become nearly or quite dry. Without water from West Virginla, the Ohio river would dwindle to a stream practically worthless for carrying commerce. As a freight carrier, the Monongahela would be a thing of the past, although it is now one of the largest carriers of freight on the continent. No other teritory of five times its size exercises the influence upon the inland navigation of the United States that is exerted by the West Virginia mountain region.

It is not in man's power to cut off or lessen to any great extent the total quantity of water flowing year by year from the West Virginia mountains into the streams, but it is within his power to largely control the manner in which the water is furnished. By keeping the mountains forested, a steady supply will be available; but if the woods are destroyed, the water will go down as destructive floods when rain has fallen, and it will as quickly disappear when rains cease—too much at one time, and not enough at another. It is within man's power to protect navigable channels from another danger—that of filling with gravel and mud washed from the land. To accomplish this, the mountains should be kept well covered with woods.

The commerce on West Virginia rivers, or those depending very largely upon this State for water, is shown in the following table, the figures being for 1906:

Big Sandy	148,623 tons.
Great Kanawha	1,613,889 tons.
Little Kanawha	106,510 tons.
Monongahela	11,447,444 tons.
Ohio	13,163,656 tons.
Total	26,480,122 tons.

This is more than one-fifth of the total river commerce of the United States. There are 282 navigable streams, and the five named above carry 20 per cent of the freight. Little of it would be carried without the water which flows from the mountains of West Virginia. For that reason, this State is of supreme importance to the Nation's inland water commerce. A greater tonnage originated on the banks of the Monongahela, and is carried by it, than on any other river of the Western Hemisphere.. A few rivers carry more, but much of it is furnished by tributary streams or comes from the sea. There are, however, only four rivers in the United States which actually carry more than the Monongahela, and two of these, the Ohio and the Mississippi, receive much of their tonnage from the Monongahela, and the other two, the Delaware and the Hudson, receive from the sea much of theirs.

The navigability of West Virginia streams ought to be maintained and further improved. The care of navigable rivers is a function of the United States Government, and it usually does not ask or receive aid from the States. But West Virginia is so peculiarly and so fortunately situated that the advisibility of joining hands with the Federal Government to promote certain works would be worthy of careful consideration in case the Government should invite such co-operation and express a willingness to follow certain lines. One such measure would be the protection of the high mountain forests, and another, the building of storage reservoirs, previously referred to in this report. If the Government should take up this work, it would do it for the purpose of improving the navigation of streams which carry inter-state commerce, and not to promote forestry, or develop waterpowers, or to assist one state alone, although these things would result as incidentals to the general purpose.

The Federal Government can not now take up the work because Congress has not enacted laws authorizing it, neither has the legislature of West Virginia passed the necessary act giving its consent to the purchase of land in the State by the Government for that purpose. The proposed act for the purchase of land in the Appalachian region for National Forests, failed to pass Congress. So far as West Virginia is concerned, the state ought to give its consent to the purchase of land by the United States in the high mounains for forestry purposes. If the care of these wide deforested areas falls entirely upon the people of West Virginia, it will be a heavy burden—but it cannot be evaded. If the Government will do part, the State ought, at least, to give its consent.

The construction of storage reservoirs in the mountains of West Virginia can scarcely be said to be under serious consideration by the Federal Government at present; but the feasibility of the project, and its bearing on the navigation of rivers, have been discussed in different Government departments, and action at some time is probable. If such reservoirs are built they will be on the headwaters of the Monongahela, the Cheat, the Kanawha and its tributaries, the Big Sandy, and probably the head streams of the Potomac. If the Government does this, it will consider it a national work; but West Virginia would derive much more benefit than any other state, and it could well afford to assist in a substantial manner, if asked by the Government to do so. Free rights of way and reservoir sites would be a small price to pay for the enormous value such improvements would be to the people of the State. Local encouragement often goes a long way toward securing help from the Government.

Irrigation.

Irrigation—the artificial watering of crops—is a form of development to which the people of West Virginia have given little or no thought. It is not a matter of as much importance here as it is in some other parts of the country and the world, because, in West Virginia, rains are usually sufficient to produce some sort of crop. Nevertheless, there are thousands of acres in the valleys of this State where irrigation would greatly increase the yield. Water in ample quantity is nearly always available at much less expense than is usual with those who practice irrigation elsewhere. It probably would not pay to irrigate grain and the coarser crops; but it would pay in many cases to resort to that method of farming where the land is occupied by truck gardens, berries and fruits. When agriculture becomes more intensive in this State, as it will and as it ought, irrigation will play an important part in the highest development of our soil resources.

The opinion is more or less prevalent that irrigation is useful in arid regions only. This is erroneous. Flowers and lawns need water between showers, and they suffer if they do not get it. Gardens and orchards often suffer from thirst which might be satisfied from neighboring streams which run to waste.

Many instances might be cited to show that irrigation brings excellent results in countries which have considerable rain the year round. Northern Italy is a case to the point. Its climate resembles West Virginia's except that it is not quite so cold in winter. The rainfall is nearly the same. Irrigation has there produced development which would be impossible without it.

The artificial watering of land need not be looked for in West Virginia until farmers and gardners see that it will pay. The State might, without much cost, investigate the matter by conducting irrigation experiments. This might be done by the Experiment Station, and no special legislation would be necessary, further than to make an appropriation for the purpose. The appropriation need not be large, but the experiments should extend through a number of years to make sure of the value of results.

Municipal Water Supply.

The health of the people is a most valuable asset. It should be given high place in the list of resources on which a State's prosperity depends. It may not be possible to measure it by dollars, but it has a money value. It has been claimed that every person that dies before his time means a loss of $10,000. to the community. The correctness of that estimate might be questioned by some, but no one will deny that human life and health, aside from all sentimental consideration, is worth looking after. The individual may protect himself the best he can, but some things he cannot do, but the state can. Few lives are absolutely worthless, and sickness always lays a burden on somebody or on the community. The health of the most obscure person is a matter for public concern; and much more so is the health of those who contribute to the country's welfare and prosperity. The struggle for existence is hard enough and progress is slow enough when conditions are as favorable as they can be made.

The difficulty of protecting the health of the people of West Virginia increases from year to year. Effort seems to slack as difficulty grows. The water in the streams becomes more impure, and the inquiries after remedies do not appear vigorous or widespread. In some cases the West Virginian uses water which a Chinaman would not touch without boiling it first. This is not meant as a criticism of corporations and companies which own municipal water works. They seem to be doing about as well as they can under the circumstances, but the circumstances are against them. The fault lies nearer the door of the whole people than to any particular doors that might be pointed out. If rivers are allowed to become so dirty that no treatment less heroic than "destructive distillation" can purify them, it is too much to expect individuals or companies to do the work. The remedy must begin at the beginning and not at the ending. The pollution ought to be kept out of the rivers, and then it would not need to be taken out. What is needed is prevention rather than cure.

The natural watercourses were once pure in all parts of West Virginia. Their drainage basins were covered with forests and farms, and the water which fed the streams was clean. Many of these streams are sewers now. Their valleys are thickly settled, their banks lined with towns and manufacturing places, mines and mills, and the offal of the land goes directly into the streams. Under present methods is can go no where else.

The trouble really begins at the tops of the mountains, where the cutting of timber has bared the ground, caused the drying up of springs once pure and perennial, and substituted surface drainage over the hard and packed soil. This has polluted the very sources of the rivers. Lower down are the mines and their sulphur drainage, camps on the hillsides with seldom an underground sewer. Further on are tanneries, pulp mills, saw mills, factories, and larger towns, all emptying their waste and sewerage into the water courses with no attempt at purification. The water supply of many towns is pumped from rivers which carry this burden of dangerous and offensive impurities. Towns with better water supplies are fortunate. Filtering plants are doing a great deal. In fact, in many instances, they virtually stand between the people and death; but science has not yet been able to devise a filter that will take out all the germs.

Impure running streams are the highways along which disease germs travel. The typhoid bacteria remain alive from six to ten days in water of ordinary temperature. That affords them time to move from the source to the mouth of any West Virginia stream. Typhoid is only one of many diseases which enter homes by way of the water spigots. Contamination from a single cholera patient on the Elbe river in Germany in 1892 infected 17,020 persons of whom 8605 died. In 1903 the Experiment Station at Morgantown published a report on rural water supply with analyses by Prof. C. D. Howard. A single item in that report will suffice to indicate the condition of some of the water then drawn from natural streams. On June 19, when the Monongahela was as pure as it could be expected to be at any time, it was found that a single gallon of water contained enough bacteria to supply one healthy specimen to every man, woman and child in West Virginia, and 300,000 left over. Three days later when a shower had washed a fresh supply into the river, a gallon held enough to give one bacterium to every person in the United States and the British Isles.

There is no reason to suppose that the Monongahela was worse than some other rivers of the state, and they are all probably much worse now than they were then. No improvement is possible as long as they remain the open channels through which the country's sewage is carried on its mission of pollution.

The opinion which is somewhat prevalent that running streams purify themselves has no fact for its basis. It is true that sunshine, if hot enough, may kill many of the germs as they pass over the shoals, but beyond that, running water is more dangerous than still water, because it keeps the germs from settling to the bottom, and as long as they remain alive they are an active menance. Deep pools in rivers do more to purify the water than is done by all the intervening riffles and shoals. The settling reservoir at Washington, D. C., precipitates to the bottom 85 per cent. of the impurities that come in with the Potomac river water. Disease germs are more often products of land than of the rivers, and unless they are washed into the stream they are not apt to get in.

Germs which are capable of producing malignant diseases, such as fever, diphtheria and others, are not the only danger lurking in the rivers. Impurities of another kind may do much injury, the acids and other chemicals for instance. According to press reports, steamers on the Monongahela late this season could not use the water from some of the pools without ruining their boilers. The water of Cheat river must have been worse, judging from the current reports that it put locomotives out of commission and that it took the hair off the legs of cattle that stood in it in fly time, and was fatal when they drank it. Conditions must be very bad when a river will tan the skin of a living cow and kill her when she slakes her thirst. It is believed by persons who have looked into the matter that scarcely a living fish remains in Cheat river between its forks and its mouth.

In the old countries, as well as in this, some of the cities use their sewage on farms and thus put to good use that which was formerly a standing menance. The city of Berlin spent $3,000,000. for land and $10,000,000. to lead the sewers to it, and is able to clear $60,000. a year on the investment. The waste is used to fertilize land. Some progressive cities and towns are following a similar plan in this country. Among them are Brockton and Farmingham, Mass., Bristol, Conn., Plainfield, N. J. Altoona and Wayne, Pa., Pullman, Ill. Hastings, Neb., Colorado Springs, Colorado, Salt Lake City, Utah, Helena, Montana, Phœnix, Ariz., and Fresno, Los Angeles, Pasadena, Santa Rosa and Redding, Cal.

This Commission is impressed with the importance of cleansing and keeping pure the rivers of West Virginia, though a degree of excellence such as the waters possessed in pioneer days can never again be attained. Rivers in other countries more thickly settled than this state are maintained in comparative purity. What others successfully do, West Virginia ought not hesitate to undertake. It is, however, no small undertaking. This region is increasing in population and adding to and enlarging its manufacturing plants. The hills are steep and the valleys narrow. Level tracts of land large enough for sewage disposal are often hard to find within reach of towns. The opening of a new mine or the establishment of a lumber plant may lead to the building of a town in a year or two. Scientific sewering and sewage disposal will find great difficulty in keeping pace with development in a State like this where so many resources are forcing their way to market.

This Commission does not feel that it has sufficient information at this time to justify it in recommending the enactment of any particular law looking to the improvement of municipal water supply, but it does recommend that the legislature take a step in that direction by providing for a special investigation of the subject. Such an investigation would not, in the opinion of this Commission, require elaborate or expensive chemical analyses of water from different parts of the State, or much bacteriological research. Such research would only show what is already well known, namely, that the rivers are a menance to health.

The investigation ought, rather direct its energies to finding out a practical way or ways of disposing of sewage without emptying it into the rivers. Engineering difficulties in leading the outfall sewers to suitable tracts of land might be the hardest obstacles to surmount.

Meanwhile such statutes as the state has forbidding river pollution ought to be enforced where it can be done without requiring the impossible. Compliance with existing laws might prove to be excessive hardships in some quarters, but there is no surer way of obtaining good laws than to enforce bad ones.

West Virginia's Resources for Manufacturing.

Factories ought to be one of the stand-bys of this State's permanent wealth. With proper care there need be no end. Abounding in raw materials of many kinds and in very great quantities, and with potential power sufficient for all present and future needs, the State is peculiarly fortunate if the people make use of resources within their reach. Except to a few students of economy who have explored the field, the extent of the possible wealth has remained practically unknown. This is especially true regarding the commanding place which the State is fitted to acquire and hold in the manufacturing growth of the country.

Figures are given elsewhere in this report to show that the waterpower in the State might be developed sufficiently to yield one million horse power, day and night, for all time. This would supply ten times over all requirements within the State at present, exclusive of steam roads, and is more than sufficient to meet their needs also. But there is another source of power, equal to that of the water for all practical purposes, and which is as idle as the water which flows unharnessed from the hills. It is the waste heap of the coal mines—not the good coal, but the rejected refuse, the poor quality, the bony remains when the merchantable coal is taken out. It is a store house of almost incalculable value.

Dr. I. C. White, State Geologist, estimates that this impure coal, which is not usually considered as a portion of the State's full wealth, amounts to fully 20 billion tons. Figures often fail to convey the full meaning of facts, and this is specially true in the present instance. Convert that coal into power for manufacturing and traction purposes, and see what the waste heap is worth. It can best be used by converting into producer gas for gas engines. If put to that use, this inferior coal would yield one million horse power, day and night for 2300 years. If placed on the market at twenty dollars per year per horsepower, the gross value would be the stupendous sum of 47 billion dollars. If all the banks, treasuries and storehouses of the civilized and uncivilized world should be raked and robbed, not enough cash could be got together to pay the value of West Virginia coal which, if present methods are to continue, will go to the culm piles and gob heaps.

The cement industry is one of many in which West Virginia can hold a commanding position. Cement has come more rapidly into use than almost any other commodity. A demand for artificial stone for bridges and other buildings, for dams, reservoirs, and many similar uses, has pushed the manufacture of cement from a low to a high point in the United States in a few years, with nothing to indicate that it will not go very much higher. Cement is made of limestone with a mixture of clay, shale or sand. Enormous power is needed to crush the materials, and heat is likewise required in portions of the work. West Virginia has everything necessary. It has enough limestone to supply the whole United States with cement, at present rate of consumption, for fully five thousand years, and by working deep quarries, perhaps a supply for fifteen or twenty thousand years would be available. It is not necessary to look farther ahead than that.

Manufacturing Region Tributary to West Virginia.

One must of necessity deal largely with the future when he bases calculations on the use of resources which now go to waste, but that is no excuse for evading the question or shirking the responsibility of meeting the issue squarely. Theoretical and academic discussions is one thing, and making things happen is another. It is time that West Virginians try to make something happen. There is a large field for manufacturing in this State. The power is here. Factories may come to the power, or the power may go to the factories. Either means development, but it is preferable that factories come here, if they will. Before electricity was made the vehicle for transmitting energy, the factory and the power plant were of necessity side by side. It is practicable now to use power hundreds of miles from the place of its generation.

On a map of the eastern part of the United States, note West Virginia's position. It occupies a mass of mountains with rivers and valleys leading in all directions. That mountain mass, with its water and its coal, is the center to which a large and populous region must look for power—if not now, certainly in the near future. Take the town of Buckhannon, which is approximately the center of the State, as a center, and with a pair of compasses describe a circle whose radius is a line which on the mileage scale represents the distance to which an electrical wire will carry power for practical purposes. The circumscribed circule will be the field tributary to West Virginia's power resources. The circle takes in Cleveland, Toledo, Detroit, Indianapolis, Louisville, Cincinnati, Knoxville, Norfolk, Philadelphia, Rochester and Buffalo and all between. The population of the region is 20 millions.

It would be an ideal condition if all the State's power could be used in the State. But if a surplus remains after home demands are supplied, a market outside should be sought. This State holds the key to the manufacturing situation, or it will hold it as soon as increased cost of steam coal compels factories to seek cheaper power. The regions east and west of West Virginia do not possess facilities for developing power. They must buy it. The regions north and south, particularly south, are a little more fortunate, but they cannot supply their own needs, and the place of last resort for power users within reach of West Virginia will be West Virginia.

A Technical School.

The suggestion that West Virginia ought to found and maintain a school of Mining Engineering to train men in the practical work of extracting and handling this State's mineral wealth has been discussed and considered in various quarters. It appears to this Commission that the scope as outlined is too narrow. It does not include enough. If this State means to establish a technical school, it should rise to the occasion and make the scheme broad enough to include not only mining engineering, but also hydraulic engineering, electrical engineering and road engineering, with the specific object of training men in the most thorough manner for the work ahead of us, as a manufacturing State. It is true that technical schools of very high order may be found in this country and in Europe; but they are doing their work, not West Virginia's.

At different places in this report figures are presented setting forth, in a general way, the State's resources now available or which may become available in the future for manufacturing purposes, either as power or as raw material. Lines were indicated which it seems probable development will follow in years to come when intelligent direction and oversight takes the place of the crude and wasteful methods of the present and past. One of the things most needed to set manufacturing development on the right road in this State is the technical training of men, the theoretical and the practical education which will fit them to direct the captains of industry, and to become themselves the captains of industry. An engineering school is needed to train men of that class fo the work which is waiting for their guiding hands and brains, and it ought to be in charge of the mast highly educated technical engineers to be had in the country. No one should be misled by the idea that West Virginia is a cheap State and something cheap in the way of industrial training school will be good enough. The available wealth of the Roman Empire in the time of Augustus was less than West Virginia's now, and less than West Virginia's will be in five hundred years from now if intelligent men manage affairs. The way to have men of the best class and of the highest efficiency is to educate them for their work, and place them in possession of every advantage which science offers. This State needs men so equipped to carry development forward, building as they go, rather than destroying as was too often done in the past. We ought not wait for other States to train the men who are to do West Virginia's work.

The need of engineers of the greatest skill is apparent, no matter what line of development is considered. Many a man can see the desirability of doing certain things, but the men are few who can find the safe, sure way of doing them. The million horsepower now going to waste in the State's idle rivers will not be utilized until engineers formulate plans for doing it, working out great schemes, project by project, locating reservoirs, protecting watersheds, building power plants, and sending the energy by wires—or wireless if science finds a way—to the manufacturing centers where use will be found for it. The same is true of the other million horsepower now lost in the culm piles and gob heaps of coal mines. It is likewise true of the resources going to waste for the want of by-product coke ovens and furnaces. No less is it true of the lost coal abandoned in mines, or cut off beyond recovery by broken strata or escaping gas.

The list might be continued. It would at every stage emphasize the need of skilled men to show how to meet and master difficulties. With not only millions but billions of dollars at stake, with the State's near future and also its remote future most vitally concerned with the people's industrial salvation, it is time to bring the question home and decide it. West Virgina will have natural resources to draw upon long after some of the sister states will have reached the limit of their industrial expansion. Waste as we may, we shall have something left for a long time. Our store is so bountiful that we could not squander it all at once if we would—and as we have tried to do with some of the assets. But why be content with a diminishing wealth when it can be made vast and permanent by directing it with forethought and intelligence? The foundation for this permanence must rest on the efficiency of the men who shape our industrial destiny.

Scenery and Resorts.

A country's natural scenery may have a good deal more than an asthetic value. It may be worth money, and from a business standpoint its care and improvement is frequently of great importance. Fifty million dollars go into Switzerland every year to pay the board and traveling expenses of foreigners who journey there for pleasure and recreation. The money thus brought into the country constitutes a large part of the income of the people. Nature gave fine scenery and pleasing summer climate to Switzerland, and the natives have built the best and most picturesque roads in Europe to make travel easy and exhilarating. Excellent hotels offer attractive accommodations. People go there to spend their money, and depart with the feeling that their money was well spent. Scenery and resorts pay in that country.

The people of Maine have found ways to make money out of their woods, lakes, rivers and summer hotels. Fishermen and hunters who have plenty of money to spend go by thousands to Maine to spend it. They are willing to pay well, and the thrifty Yankees see to it that their guests get their money's worth. That brings the guests back year after year. Game is protected and is plentiful. Streams abound in fish because dynamiting and other destructive modes of killing are not permitted. The woods are in good condition because fires are not permitted to burn unopposed. The people of Maine find their scenery, resorts, hunting and fishing an investment which pays big dividends.

West Virginia has not, up to the present time, done much with its scenery except to mar it, mutilate it, and burn it up. Except in the case of mineral springs, practically nothing has been done in this State to make scenery attractive or to bring it to the attention of the outside world. West Virginia may never rival Switzerland, but it can equal Maine. The summer climate is glorious among its high mountains and elevated valleys. A series of summer hotels from 3000 to 4400 feet above the sea might stretch across the State, following the Alleghany and parallel ranges of mountains.

Adequate highways connecting these resorts, and others for side trips to hunting and fishing grounds, with the surrounding forests cared for, and the innumerable mountain streams clear and clean, would attract to West Virginia many thousand wealthy tourists who now hardly know the state by name and who never think of visiting it, except to rush across it on the limited express trains of trunk railroads.

A good many things must be done before West Virginia will take its due rank as a resort for tourists, healthseekers, and sight seers. It must first protect its woods and make them attractive. It must clean its streams and stock them with fish, and make and enforce civilized laws for protection of the fish. It must stop the senseless slaughter of birds and game. It must build roads that can be traveled with speed and safety by modern vehicles. In building these roads the value of scenery must be considered in regions where scenery is attractive.

The steps necessary to the carrying out of anyone of these recommendations are many, expensive, and difficult. No one should suppose that it is possible to do such things by simply resolving that they ought to be done. The immediate duty is to make a beginning and to make it in the right way and in the proper direction. Then build upon that beginning as it becomes possible to do so. Check forest fires first; lessen the pollution of streams; put all new roads on the best grades, and when old ones are changed, put them on proper grades also; make it so dangerous for fish-dynimiters and game-destroyers to ply their trade that they will migrate. Follow these beginnings with constructive work; stock streams anew with fish; the forests with game and bird; build roads as circumstances will allow; and take pains to let the outside world know that West Virginia is in the scenery and resort business.

If the time shall come when immense storage reservoirs occupy a number of the elevated valleys among the mountains of West Virginia they will constitute an important factor in the development of the State's scenic resources. They will add more than almost anything else can add to the enjoyment of persons who visit the mountains, as well as to the people who live there. To all intents and purposes they will be high mountain lakes, suited to sail. launch, and canoe. They will cover hundreds, and in some cases, perhaps thousands of acres, and abound in fish and fowl. The reservoirs are not yet built, of course. They may not be built for a long time; but it is reasonably safe to count on them as one of the most attractive features of our mountain scenery in years to come.

In this connection it seems proper to speak a little more particularly of the general failure which has lately attended the efforts at enforcing fish and game law in this State. Theoretically, the laws are good. There is ample penalty for violation, and the means for enforcement were supposed to be well thought out. But results have not been obtained. This Commission has no sweeping change to recommend in the law, but it suggests that any system making use of secret spies and informers will be a failure because of popular disapproval of that method. It is further apparent that when excessive penalties are meted out according to the letter of law rather than its spirit, the wrong person is often made the chief sufferer. This is not in accordance with popular and enlightened sense of justice, and as a corrective measure it cannot succeed. If the legislature contemplates a revision of fish and game laws it might be worth while to consider whether road overseers, or constables, or school trustees, might not be the proper persons to act as deputy game wardens for their respective neighborhoods. This would be an increase in the duties of officers already in existence, rather than a multiplication of officers. They should, of course, act under the authority of the State Warden. That would place the execution of the law in the hands of the people of every community, and every neighborhood would know that one or more of its own citizens had an eye on violators. That would remove much hostility to the game laws which heretofore has existed—and not without reason—because of the knowledge that outsiders were prowling about the neighborhood and spying on the people. Much of the failure of the laws has been unquestionably due to this feeling. When the law's machinery is not respected, the enforcement of the law is difficult.

Agricultural Lands.

There are 15,859,200 acres of land in West Virginia. It is estimated that about one-third or 5,475,915 acres of the total was devoted to agriculture in 1900, since which time much additional land has been cleared and brought under cultivation. This includes that portion of the farms which was never cleared. A portion of this estimated one-third should not have been cleared for reasons hereinafter stated, but should have been left in permanent forest. On the other hand, a large portion of the present forest area is well adapted to agriculture, especially to fruit growing and sheep husbandry.

Between seven and eight million acres of land in the State are of such topography and soil as to adapt them permanently to agriculture.

We have made no attempt to tabulate the acreage devoted or adapted to particular lines of agriculture for the reason that there are no complete or reliable statistics available, and in this connection we desire to direct particular attention to the paucity of data bearing upon this and other important inquiries which we have had under consideration.

The following table shows by decades the number of farms in the State, the total acres including that which is still in forest, cut over lands, or wood lots, and the average size of the farms:

Year.	*Number of Farms.*	*Total Acres.*	*Average size.*
1870	39,778	2,580,254	214.4
1880	62,674	3,792,327	162.6
1890	72,775	4,554,000	141.8
1900	92,874	5,498,980	114.7

It is seen that as the farms increase in number they decrease in size.

The table which follows gives the value by decades of the farms in the State.

Year.	*Value of Farms.*	*Value per Acre.*
1870	$ 96,714,190 00	$14 88
1880	120,892,738 00	15 07
1890	153,588,725 00	17 34
1900	203,970,349.00	19.14

Under the system of valuation of property inaugurated by the State during this decade the total valuations of farm lands will be wonderfully advanced in 1910. All these lands were originally in forests. The quality of such timbers as white oak, red oak, yellow poplar, hickory, cherry, black walnut, pine, spruce, and hemlock was of the very finest. The evidence goes to show that the finest and by far the most valuable of all our timbers were upon the lands that have been cleared and brought under cultivation, and that until recently all of that timber except such as was used immediately upon the farms for fences, buildings, and fuel, was burned or otherwise destroyed. The fact that such fine timber grew upon these lands was proof sufficient to the early settler that the soils there were wonderfully fertile. The course pursued in clearing these lands was to grub or hack the underbrush and then pile and burn it. Then the small and medium sized trees were converted into fence rails or cut and piled in log heaps and burned. The remaining larger trees were belted and left standing until they were destroyed by fire and decay.

It was commonly observed that these lands when cleared seemed to spring up spontaneously in blue grass, and many persons then believed and some now think that the seeds of that magnificent grass were in the soils under the forest leaves and only awaited the letting in of the sun to spring up in luxuriant pasture.

When the lands were cleared they were usually given over first to hoe crops, corn, potatoes, tobacco, etc., that being the easiest way to secure a crop and at the same time to subdue the sprouts and other wild growth. After these came meadows, wheat, oats, buckwheat, rye and permanent pastures.

The first lands cleared were the creek bottoms along the banks of the principal streams, the Ohio, Kanawha, Monongahela, Greenbrier, Potomac and their larger tributaries. The alluvial soils of these bottom lands were so fertile that they were regarded as inexhaustible like the overflowed lands along the river Nile. No thought was given to intelligent rotation of crops or cover crops to hold the richness or stay waste. In fact, but little was then known of such practices. No one thought of the time when the productiveness of these soils would steadily decrease, or of that more calamitous time soon to come when the maximum annual production of all the soils would be equaled or surpassed by the annual demand of the people for food.

After the large bottoms were cleared, came those of the smaller streams; and, as the population increased, the foothills and higher slopes were attacked until now fully a third of all the lands of the State has been brought under some sort of cultivation. This has been going on more than a century and it is still going on. Out of the whole clearing, there are tens of thousands of acres that should have remained in forest. They are too steep for any kind of clutivation. This has occurred all over the State. Such lands when plowed are subjected to speedy and terrible injury from soil erosion or washing. This is evidenced by the quick impoverishment of the soils, and by the mud-laden waters that pour out of the hills in the streams all over the State after every freshet. But this is only one of the great drains upon the soil wealth of our State. This injury is visable to all and is terribly destructive to our greatest source of wealth; but it is not the greatest by any means, as it is limited or confined to the steeper slopes.

Like the escape of natural gas from leaky pipes and unplugged wells, another source of loss is constantly going on unobserved, and this is soil leaching. The soil elements upon which plants feed must first become soluble in water. The growing plants drink up the water and thus appropriate them. The more expensive and exhaustible of these elements are lime, potash, phosphoric acid, and combinations of nitrogen. Thus when the soil is not under proper management and there is an abundance of moving water present in the soil, the soluble elements are constantly being taken up in solution and carried away in the drainage waters which flow eventually into the sea and are lost to agriculture. In this way the greatest losses to soils occur. In the case of uncultivated or permanent grass lands, the loss of plant food is so small as to be negligible, but as soon as man begins to changs this order of things and to pursue a course of soil mismanagement and neglect, the loss from leaching alone is tremendous. When considered from the standpoint of the nation, the aggregate annual loss from that source is incalculable. Investigations of this subject conducted on some of our richest lands show the annual loss of plant food by leaching alone to be many times the total amount carried off in the crops. Every year in West Virginia many thousands of acres of land are grown in corn, wheat, buckwheat, tobacco, potatoes, etc., and the crop is removed and the land is left unprotected till the following spring. In the meantime soil drainage goes on silently but surely, robbing the lands of our greatest and most enduring source of wealth.

There are good reasons for believing that the annual loss to the people of West Virginia by soil erosion and leaching is far greater than that suffered by the removal of all the crops. Such losses are hard to estimate because no records have been kept. Take, for example, the loss of the single soil constituent, nitrogen, due to the single cause of leaching.

Experiments have shown that an average soil of this State farmed to grain only, loses each year nearly forty pounds of nitrogen by leaching alone.

Suppose that for the sake of keeping well within safe limits we put this loss at thirty pounds per acre (which is more than a ton of the average nitrogenous commercial fertilizers coutians) and that (for the same reason) we assume the amount of land so affected to be one-half the arable land or 2,500,000 acres, bearing in mind the fact that farmers pay about twenty cents per pound for nitrogen in commercial fertilizers, which nitrogen is as a rule not as valuable as that which is lost by leaching—and we begin to get a faint conception of losses that are just as real as any that may be charged to waste of other resources. It is fifteen million dollars a year. And yet this example has to do with but one way in which one soil constituent is wasted. The amount of nitrogen lost by washing from a hillside acre of soil, plowed for corn, is much greater, and all other constituents go to the rivers with it in whatever proportion they may be found in the finest and best of the soil.

But these irrational farm practices do not stop with letting the best of the soil get away. They are often responsible for conditions which greatly lower the fertility of what remains. An example of this is seen in the acid condition of the soil which the Experiment Station's work has shown to be so common throughout the State. Sufficient data for an accurate estimate of the losses due to sour soils is not yet at hand. There is reason to believe however, that fully one-fifth of our arable soils have become acid, and it is known that much more than half a crop from such soils is out of the question.

But the injury due to an acid condition of the soil does not stop when it has interfered with the processes that make inert plant food available in the soil. It forestalls the possibility of a normal accumulation of nitrogen from clover and other leguminous crops, and makes it easier for the available phosphoric acid in the soils to get away by leaching. This doubtless accounts for what every one knows to be true, that so many of our soils respond so gracefully to an application of acid phosphate. The enormous quantities of acid phosphates purchased yearly may serve in a measure to show how prevalent the acid condition is.

Many other examples might be cited, but suffice it to say that in the wanton waste of the State's most precious resources, agriculture discounts all other industries. In no other does the amount wasted exceed the amount used. In many instances the quantity wasted, although enormous in the aggregate, is but a small part of the amount used. In agriculture, however, the amount lost is often far more than double the amount used.

Our soils are the greatest of our natural resources. The maintenance of their fertility is the greatest problem confronting us. The losses could be easily and profitably stopped, and there is just as much reason for plugging our soils with cover crops, etc., to stop losses by leaching and washing as there is for plugging a gas well.

Last year our crops in West Virginia sold for $72,000,000. or twenty-four times the total revenues of the State. If we could stop the loss of the additional $72,000,000. that goes off yearly in drainage water to be lost in the sea, it would double our crop yield. With this immense sum, wonderful achievements might be wrought for the common good, by way of stopping State taxes, the building of fine country roads and schools, and the establishment of splendid libraries and universities, agricultural research departments and schools, and many other good things for the alleviation and elevation of our citizenship.

The man who grows an acre of corn and then leaves the land to leach all fall and winter and early spring is just as guilty of waste as the man who fails to plug a gas well or the man who uses a bee-hive coke oven. The principle is the same.

A statute requiring the farmer to stay the waste of soil fertility would be as fair as would be the legislative mandate to the coal or gas man. Indeed is it not more necessary? For humanity can get on without natural gas, and it may soon have to do without coal, but without the products of the soil, never. More men who are skilled in the practices and trained in the sciences that underlie economical and profitable soil management and crop production should be enlisted by the State in finding out more and teaching more to the farmers of what is necessary to prevent the waste of our soils. In fact the whole problem of the conservation of natural resources and the stopping of their wasteful use must be a matter of research and education. The soil wealth of land is the accumulations of the ages handed down to us as a sacred trust, not to be wasted but to be economically used, augmented where possible, and kept intact for generations yet to come.

The conservation of the soils fertility is a matter of first importance, because a supply of cheap food is an indispensable pre-requisite of a people's prosperity. Impoverished soil and cheap food do not go hand-in-hand.

Whenever these losses are permitted to continue for a series of years, the soils become impoverished to such an extent that profitable crops cannot be grown any longer and the land is abandoned, or commercial fertilizers must be employed to obtain profitable yields. The extent to which our soils are being wasted by improper management may be in some measure estimated by the value of commercial fertilizers used yearly in the United States. Secretary Wilson says in his last report that the amount in the United States annually exceeds $100,000,000, but he also said in his address before the Governor's conference at the White House last May that farmers of the great Mississippi valley did not use fertilizers because they could not get them.

This tremendous drain upon the agricultural resources of West Virginia could be prevented almost entirely if our people understood the principles of better soil management and would modify their practices accordingly. No amount of penal legislation will accomplish the end. It can be done by teaching the land owner how to do it and then showing him that it will pay. This to be applicable also to a greater or less extent to the conservation of other resources.

West Virginia is marvelous in its wealth of forest and minerals, but richer in its soils. There is an annual rainfall of about forty inches. This insures bountiful crops. All of our soils, excepting the alluvial bottom lands, are sedentary, that is, soils which originated where they are. Under proper management, their fertility may be conserved and their crop yield maintained indefinitely. The low yield of wheat and oats in the

State warrants the belief that we should abandon growing them. The change in markets and other conditions demand changes in the order of farming. More of the bottom lands, together with the nearby foothills, could be profitably used in dairying. Commercial culture of fruit has made great progress in the State in recent years. This is especially true of apples and peaches. The yield per acre, of these fruits is not surpassed anywhere in America, and they always sell at top prices in the leading markets. Fruit growing is destined to become more general in the State, and it should be encouraged.

The steeper lands should be returned to forests or given over to sheep husbandry. Sheep raising can be carried on with a minimum loss to the soil. Indeed, it is claimed that the soils so used grow richer, and there are good reasons for the claim. The plow on steep land is one great cause of soil waste. This would be unnecessary to any great extent where sheep are raised. Instead of 675,000 sheep in the State as at present several times that number may be kept successfully. Well informed flock-masters assert that in the higher, steeper lands now held for agriculture as many as 6,000,000 sheep might be kept and that these will yield in wool and mutton an annual return of five dollars per head or a yearly income of $30,000,000. When we consider that about one-fifth of all the sheep in the State are now in two small counties, and that they constitute about one-fourth of all the sheep value in the State, it appears that 6,000,000 sheep are not too many for West Virginia.

The average yield of wheat in West Virginia is 12.2 bushels, and of oats it is less than twenty bushels per acre. In most cases commercial fertilizers are used on these crops. There is no profit in this. There are now 462,000 acres used for these cereals that should be devoted to trucking, dairying, poultry, live stock, and fruit growing, all of which under proper management in West Virginia will prove very profitable.

Where fruit growing is conducted on steep slopes, little or no plowing should be practiced, and the mulching system must finally be adopted. In the management of hill lands we must seek those lines of agriculture which require the least plowing. These are fruit growing, poultry culture, forage crops, and sheep husbandry. On the lower and leveler lands, trucking, stock feeding, and dairying should be pursued. None of our cultivated lands should be permitted to lie over winter without some growing crop on it such as winter vetch, winter oats, rye, or grass. In this way the awful losses from soil erosion and leaching can be greatly reduced.

The development and utilization of other natural resources will largely increase the population in West Virginia in the near future. This will constantly increase the demands of our home markets which are now the best markets on earth. It is the duty of the West Virginia farmer to so change his methods and improve his practices as to meet this demand with the greatest profit, and least exhaustion of the soils. Wherever lands are plowed they should be subjected to the most intense cropping and then quickly returned to grass or forage crops.

We occasionally hear of abandoned farms in West Virginia, but we should not be misled into the belief that these farms are worn out, for they are not. It is true that they have been mistreated and abused, and temporarily worn, but they are still rich in plant food and may be quickly brought up to a high state of fertility. The materials out of which they were originally constructed are still there. The metal of what is left is as fine and well tempered as of that which was wasted, and like the barber with his dull razor, all that is needed is the skill to restore the edge. Our Experiment Station has within six years brought up such worn lands from an annual yield of one-half ton of poor hay to a permanent and profitable yield of four and one-half tons of the finest hay. One of our senators made the remark that if our farmers would follow closely this example on their lands, they would receive more net money for one hay crop than they received for all their coal, and the coal once sold is sold forever.

If there are abandoned farms in West Virginia, it is not because they are worn out. They were left for the same reasons that carried thousands away from the farms of Ohio, Illinois, and Iowa to the alluring broad acres of Texas or Oklahoma, or the Northwest, or Western Canada. The Anglo Saxon is constitutionally a land lover and he will always go after good, low-priced lands. These are the reasons for the abandoned farms of West Virginia. There is not a farm in this State that cannot be made to yield a good living for an up-to-date farmer, and six per cent net annual profit.

Conservation of our natural resources consists in intelligent use not in disuse or abuse. The potentialities of our soils have never been put to the test. With a better knowledge of their requirments, and with proper management, they may be made to yield a vast increase of profitable crops for centuries, and still be rich. The danger to soils doe not consist in what is removed in the crops, but in what is wasted in bad practices.

We need to be taught how to enrich soils and keep them so, and at the same time to take away the yearly quoto of crops. To do this we must know our soils better, and must understand more clearly their deficiencies and adaptions. Such information can be had only as the result of careful investigations by experts, who should be provided in each congressional district with lands sufficient not only to study the peculiarities of the soils of such sections, but also to demonstrate the results of such investigations and the better practices already well known, but not yet appreciated by farmers. This is the only sort of "agricultural extension among the farmers" that will ever be worth a tithe of what it costs.

The experiment station is doing good work on the soils of the State, but its limited facilities for so gigantic an undertaking should be multiplied.

The soil survey of the State Geological Survey, in cooperation with the Bureau of Soils, U. S. Department of Agriculture, just begun, will be of great value in every systematic investigation of soils and should be completed as soon as possible.

Much has been done and enough is already known to reduce greatly the losses in soil fertility and to build up our mismanaged soils. What is needed first of all is to bring home to the farmers the follies of existing irrational agricultural practices, and no amount of lip service will ever do this. It must be done by those whose knowledge of our soils enables them to demonstrate to the farmers that there is a better way.

More than a thousand millions of tons of our richest soil are swept into the sea every year, clogging the rivers on its way and filling our harbors. Less soil, less crops; less crops, less commerce; less commerce, less wealth."

PART IV.

RECOMMENDATIONS AND SUGGESTIONS.

Following is an epitome of the Commission's recommendations and suggestions. Each is more fully set forth in preceding pages of this report, together with the data on which it is based.

It is recommended that three laws be placed on the statute books of West Virginia:

First, a forest law, providing for the prevention and suppression of fire, and for the care of woodlands and water courses. The full text of the law as suggested in this report is given.

Second, a law to lessen the waste of natural gas. What is known as the "Indiana Law" suits conditions in West Virginia. It provides for plugging wells when not in use, and saving the gas from others, and forbids leaky mains. No copy of the law is included in this report, because it is well known.

Third, a law setting a time five years hence, after which none but by-product coke ovens shall be built in West Virginia, but placing no restrictions on the use, as long as they last, of any ovens which may be in commission on December 13, 1908. A copy of the proposed law accompanies this report. This State ought to cooperate in all reasonable and practical ways with the Federal Government in the improvement of our navigable streams, protection of mountain forests, and in the building of storage reservoirs.

The establishment of an engineering school, including mining, civil, electrical and hydraulic engineering for the direct and specific purpose of training men to develop and manage West Virginia's natural resources, is worthy of serious and speedy consideration.

The fish and game laws of the State have failed. Something else is needed at once. The suggestion is made that constables, or road overseers, or school trustees, be made local wardens, acting under a State Warden, thereby providing a local man to look after the enforcement of the laws in every neighborhood. A change in the present law would be necessary before it would fit the suggested new order.

Fuller investigation of municipal water supply, and the sanitary condition of running streams of the State is recommended, with insistence upon the necessity for speedy action.

Special attention has been given to the waste problems of the State. The fact is recognized that the cure for some of the evils will not be found in legislation so much as in education; but with others, laws are needed more than education.

It appears that certain of the valleys of West Virginia might be made much more productive by irrigation, and it is recommended that experiments be carried out to test whether it would be profitable.

The value of the State's natural scenery from a business standpoint might be made very great; and it is suggested that this be borne in mind in all road building among the mountains, and in the enactment of all game and fish laws, and laws for keeping the streams pure.

In his address before the Governor's Conference last May, Andrew Carnegie said, "Nor can we consider ways of preserving the supply without realizing the need of wider and deeper knowledge than we now possess. The most careful inventory of the family patrimony should be made. I urge as our greatest need today, the need of better and more practical knowledge. It was never more true than now that knowledge is power."

We recommend that some permanent agency be employed for gathering complete and detailed information of all matters concerning the affairs of our people in this State and that these statistics be assembled and assimilated and published annually so that our people can have the benefit of such knowledge.

We recommend the establishment of an immigration agency in the State for the purpose of advertising to the world the advantages of rural life in West Virginia and that it be required to employ means for bringing more desirable men as laborers and owners and managers upon our soils, whether from this or other States and countries.

Results of our inquiries show that the cost of travel and the movement of farm products and supplies over our country roads is a tremendous drain upon the annual income from the products of soils. There is nothing else of such importance to the rural people of West Virginia as that of highway improvement. And we recommend that the State set about the building of permanent up-to-date roads in every portion of the State.

There is great need of more scientific investigation and instruction in West Virginia among our people in regard to agriculture and we recommend that larger appropriations be made and larger facilities be afforded for carrying on this work hereafter.

We believe that the purchase of lands by the State in each Congressional District, which may be managed and conducted as model farms for the purpose of carrying on investigations and of illustrating and demonstrating to our farmers better practices and more profitable methods will be of great benefit to the people and that in the end such outlay would not be an expenditure on the part of the State but would be a profitable investment.

PROPOSED FORESTRY LAW.

A Bill for the establishment of the office of State Forester, providing for the suppression and control of forest fires, the preservation of forests and for other purposes.

Be it enacted by the legislature of West Virginia.

Sec. 1. For the protection, preservation and restoration of the forests and forest lands within the State of West Virginia, it is hereby enacted that the office of State Forester shall be and is hereby created with powers, functions and duties as hereinafter set forth in this act; together with such regulations and provisions for preventing and extinguishing forest fires as are herein further provided, and with provisions for the care and protection of woodlands and streams within the State of West Virginia.

Sec. 2. It shall be unlawful for any person to set fire to any forest, grass, or undergrowth on land within this State. Any person so offending shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine of not less than twenty or more than five hundred dollars, or by imprisonment in the county jail not less than ten days or more than six months, or by both such fine and imprisonment. Any person building a fire upon any lands for camping purposes, or otherwise, shall carefully provide against the spreading of such fire into or through any land. Any person who shall cause a forest fire by carelessly, negligently, or deliberately dropping a burning match, or emptying fire from a pipe, or dropping a lighted cigar or cigarette, or discharging a combustible wad from fire arms, shall be deemed guilty of setting the forest on fire. All railroad companies operating steam locomotives through, over or upon forest lands within this State shall provide all such locomotives with sufficient spark arresters. Any failure to do so, and which results in the spreading of a forest fire within this State, shall be construed to have been the careless act of such company or its agents by which a forest was set on fire, and shall be punished as such. The words "Forest lands" when used in this act shall be construed to mean any tract of woods enclosed by fence or unenclosed containing one acre or more, whether such tract shall belong to one or more than one person. Any tract of land, of one acre or more, containing a sufficient growth of trees, brush and leaves to render it unfit for grass or grain in its present condition, shall be deemed to be forest land within the meaning of this act.

Sec. 3. All duly elected or appointed constables within the State of West Virginia are hereby declared to be, and are ex-officio fire marshals for their respective magisterial districts, and their duties and powers shall be as hereinafter set forth. The State Forester may, in his discretion, appoint additional fire marshals in magisterial districts where they are needed. All deputy game wardens within the State of West Virginia shall be ex-officio fire marshals, in and for any magisterial district of West Virginia, where they may be present at the outbreak or during the progress of a forest fire. Immediately upon the outbreak of a forest fire within any fire marshal's district, he shall proceed to the place of the fire and take measures to extinguish it. It shall be his duty to warn as many of the able bodied male residents of his district, between the ages of 18 and 50 years, as he may consider necessary, and he shall direct them to proceed forthwith to the fire, and, acting under his orders, extinguish it. Said marshal may deputize, in an emergency case, any suitable person to assist in calling out the resident fire fighting force. Any person so warned, either by the fire marshal or his deputy, to assist in extinguishing a forest fire, and shall fail or refuse to obey without lawful excuse, shall be deemed guilty of a misdemeanor, and upon conviction before a justice of the peace of such disobediance or refusal, he shall be fined not less than five or more than twenty dollars.

Any fire marshal who, without lawful excuse, shall fail or refuse to act promptly upon receiving knowledge or information of the outbreak of a forest fire within his district, shall be liable to indictment for neglect of duty, and upon conviction he shall be punished by a fine of not less than twenty-five or more than five hundred dollars, or by imprisonment in the county jail not less than ten days or more than six months, or by both such fine and imprisonment. No person shall be liable to action for trespass who, in good faith, enters upon the land of another for the purpose of extinguishing forest fire. No person who, exercising reasonable judgment and acting in good faith, shall set a back fire for the purpose of extinguishing a forest fire; shall be prosecuted or held blamable for the consequences of such act. The collection of all fines imposed in accordance with the provisions of this act may be enforced by imprisonment in the county jail at the rate of one day for each dollar of such fine remaining unpaid. All fines collected by the authority of this act shall be paid into the general fund of the county in which they may be collected. In the absence of a fire marshal, or if he is unable from any cause to act promptly, and if the danger from a forest fire is apparent and so imminent that delay would increase the danger, any resident of the State who himself sees the danger may, in that emergency, assume of his own volition the authority of the marshal, and by that act become a special marshal for that time and place only. He shall proceed by proper and necessary means to extinguish such fire. If two or more persons assume such authority at the same time, and there shall result a conflict of authority among them, the oldest man shall act. However, if the marshal shall arrive at the point of danger, before the fire shall have been extinguished, the special marshal shall report to him at once and relinquish his official authority.

Sec. 4. It shall be the duty of any fire marshal when a forest fire has occurred in his district, to diligently inquire into its cause, and ascertain, if possible, by whose act the fire was caused. Unless he be fully satisfied that the outbreak of such fire was purely accidental, or unavoidable, and not due in any way to neglect or carlessness, he shall procure a warrant and arrest the person or persons responsible for the spreading of such fire. Or, upon view, he may make such arrest without a warrant; the person or persons so arrested shall be given a hearing before a justice of the peace and shall be dealt with according to law. Any person accused of setting a forest on fire may prove, as a proper and adequate defense, that the setting of such a forest on fire was not by any wilful, careless, negligent, or reckless act of his; that it was not caused by any unlawful act of his, or by him while doing any unlawful thing; and further, that though he accidentally and without blame caused the fire, he promptly did all in his power to extinguish it, and as soon as possible spread an alarm among the people.

Sec. 5. Any person who performs service in extinguishing a forest fire, after having been duly warned by a fire marshal so to do, shall receive pay from the treasury of such county in which said service was rendered, at the rate of fifteen cents for each hour actually engaged in such service, upon proper certification by the fire marshal of the district that such service was rendered. Any fire marshal who has been actually and necessarily engaged in extinguishing a forest fire in his district, shall be paid from the treasury of such county the sum of twenty cents for each hour so engaged, upon filing with the county clerk an itemized account under oath of such services. He shall be paid at said rate of twenty cents per hour for warning the citizens to assemble and extinguish a forest fire, and he shall receive no other pay for such service. Any person lawfully acting as a special or deputy fire marshal shall receive pay at the same rate and in the same manner as the fire marshal. It shall be the duty of any fire marshal in any district in which a forest fire shall occur, and for the suppression of which one or more citizens shall have been called into service, to make a report, within ten days after such fire to the State Forester, upon blanks furnished him for that purpose by said State Forester, and such blanks shall call for full information concerning the cause of such fire, its extent, means employed in fighting it, the damage done, and such other information as the State Forester shall deem necessary. For such report so made the fire marshal making it shall be paid one dollar from the county treasury, and he shall keep a duplicate of such report in his office upon a blank furnished him for that purpose by the State Forester. Any fire marshal who shall fail to make such report as herein provided, without lawful excuse for such failure, shall be deemed guilty of a misdemeanor, and upon conviction he shall be fined not less than five or more than fifty dollars.

Sec. 6. Within ten days after the conclusion of a hearing before any justice of the peace, of any person accused of a violation of any provision of this act, it shall be the duty of such justice of the peace to make to the said State Forester a report of such hearings, upon blanks furnished to him by the State Forester for that purpose, and to keep a duplicate on file in his office. For such report he shall be paid one dollar from the county treasury. Whenever any trial upon indictment or information has been held in any court of this State, of any person charged with a violation of any provision of this act, it shall be the duty of the clerk of such court, within ten days after such trial, to make report of such trial to the State Forester upon blanks furnished to him for that purpose by the State Forester. For such report said clerk shall be paid one dollar from the county treasury.

Sec. 7. It shall be the duty of the State Forester to furnish necessary blanks to all officers requiring them in the discharge of such duties as are created by this act. He shall preserve and compile all statistics coming into his hands and which he shall deem essential to a proper study and care of forest lands in this State. He shall supply all necessary and available information to district fire marshals concerning their duties and how best to perform them. He shall inquire concerning, or make a personal examination of all forest lands belonging to the State, or becoming the property of the State in any way, and shall ascertain whether such lands ought to be retained by the State for forestry purposes and to protect streams, springs, and water courses, and he shall take proper and necessary measures for the care and protection of such lands. With the consent and approval of the Governor he may withdraw from an offer of sale such forest lands belonging to the State as ought to be retained by the State for the protection of springs and streams of water, but he shall enter into no contract, in the name of the State, for the purchase of land, unless the legislature, by act, shall first so authorize and shall make an appropriation for that specific purpose. He may consult with persons owning forest lands in this State, or deforested lands, and advise them concerning the care of such lands, and their reforestation, if barren. Such advice and assistance as is given shall be without cost to such land owners. He shall do other proper, practical, and necessary things to promote the interests of the forest lands within this State, and to protect, care for, prevent stagnation, and maintain the natural springs and water courses; and to prevent the outbreak and ravages of forest fires. He may meet with, consult with, and discuss with, at proper times, and places, and when the welfare of the State can be conserved thereby, conferences congresses, meetings, gatherings, and associations held in other states to consider and promote the interests of forestry and the maintenance of natural water courses in the Appalachian region. He shall make a written or printed report to the Governor at least once in two years, and oftener if he deems it necessary, or if the Governor of the State shall request him to do so. The State Forester may, in the discharge of his duties, enter upon any forest lands in the State, and he shall not be liable to any action of trespass therefor.

Sec. 8. Within ten days after the passage of this act the Governor shall appoint a State Forester. The term of such office shall be four years, and the succession in office shall be by appointment by the Governor every four years, or whenever a vacancy shall occur. He shall receive a salary of $———— dollars a year, and in addition thereto he shall be reimbursed for all actual and necessary expenses of travel which may be incurred in the discharge of the duties of his office, for all blanks, books, stationery, apparatus, and supplies necessary to the proper discharge of the duties of his office, and for actual and necessary office rent and office assistants.

Sec. 9. To meet the expenses of the office of State Forester an appropriation is hereby made of five thousand dollars for the year 1909, and a further sum of five thousand dollars for the year ending 1910. When claims are certified by the State Forester and sworn to by the claimant they shall be paid out of the State Treasury upon a warrant of the Auditor of the State, provided that the total amount expended during the two years herein specified shall not exceed the amount hereby appropriated. The Auditor of the State is hereby authorized to draw his warrants upon the State Treasurer against the sums herein appropriated, upon the presentation of proper vouchers, and the State Treasurer shall pay the same out of any funds in the public treasury.

Sec. 10. The State Forester shall have authority to make and enforce proper rules and regulations for carrying out the spirit of this act.

PROPOSED COKE BY-PRODUCT LAW.

A Bill to Lessen the Waste of By-Products in the Manufacture of Coke.

Be it enacted by the legislature of West Virginia:

For the prevention of unnecessary waste in the manufacture of coke, it is hereby enacted that after the first day of January, A. D. 1914, it shall be unlawful to build for manufacturing purposes in the State of West Virginia, any coke oven which shall not be provided with adequate apparatus for collecting the merchantable by-products of coke manufacture.

Any violation of this act shall be a misdemeanor and shall be punishable by a fine of five dollars for each day any such oven shall be used for manufacturing coke.

Provided, however, that nothing in this act shall be construed to prohibit or restrict the use of any coke oven fully completed on or prior to December 31, 1913.

EXTRACTS FROM LETTERS.

The Commission addressed letters to business men in different parts of the State inviting suggestions as to how the work of conservatism might be carried on, and the lines it ought to follow. Below will be found extracts from and abridgments of a number of the replies. They are inserted here for the light they throw on this problem from the view-points of men of various callings and of different political opinions.

The forest area of the State can be increased by proper care of what we now have and a more conservative mode of cutting by the manufacturers together with a sufficient corps of State officers to see that the laws that are now in force and those that may be made are complied with.

At present, fire is causing the greatest loss to our forests, especially to tracts that have been cut over. On these old choppings the heat is so intense that it kills not only all the young timber left but in the spruce and hemlock sections even burns up the soil and entirely destroys the seed bed which will take centuries for nature to again restore to a proper condition for the growth of timber.

Quite a large territory of our State is covered with this kind of timber both in the original forest and cut-over lands.

Further, in this section are the fountain streams of all our principal rivers some of which are important water-ways to other states than our own. Year by year the acreage of barren lands is increasing and if nothing further is done than what has been done toward protecting our forest lands from fire, the time cannot be very long, comparatively speaking, until this entire territory will be a barren waste of lands without moisture or soil to reproduce a timber growth. I believe the first and most important move will be for the State to take hold of the matter in a systematic and vigorous way and to devise ways and means to prevent fires in our timber lands.

I would suggest that a nominal tax be levied on all mountain and forest lands not occupied or under occupation in the State sufficient to defray the expenses of maintaining an ample number of fire wardens at a salary that will justify them in givin this matter their time and attention; in connection with this, they could also act as game wardens. They also should have the power to employ deputies and other help in case of fires getting out and beyond the control of those responsible for such fires. Railroad companies, lumber manufacturers or other corporations should be in some way held responsible for protection for their own property from fire along their right-of-way or about their operations.

Further than this I believe the very best thing that could be done along this line would be for the Federal Government, assisted by the State, if necessary, to buy up all the mountain and forest lands possible of all kinds on the territory embracing the headwaters of our important streams and have all lumber operations conducted under the direction of the Bureau of Forestry whether on private lands or on lands belonging to the State. This would take in a large territory including several counties of old Virginia. No other water-shed is of as much importance in the Appalachian mountain system. From this source the national capital depends for its water supply as well as do many other large cities, and thousands of square miles of territory. To preserve this water-shed is just as important to the National Government as it is to the State. It would be a better investment than was the purchase of Alaska especially in the betterment of conditions for thousands of families and manufacturing industries for time to come and which will pay millions of revenue yearly.

I believe our State law-makers are in every way competent to take hold of this matter and entirely eliminate all forest fires in the State if they can but see the great importance of so doing.

J. C. WATSON,—*Mineral County.*

A modern system of farming is needed to increase production of farms; and better roads would add from 200 to 300 per cent to values. The remedy does not lie in the bringing in of immigrant farmers. More stringent laws against forest fires, and laws to limit needless waste in lumbering are needed.

W. P. HAWLEY,—*Mercer County.*

The question of conserving the State's resources covers so great a field and includes so many economic topics that a detailed study would be necessary before offering any practical suggestions. I feel, however, that something ought to be done, at least in the way of stopping needless waste. I realize that there is another side to the question—that of the operator and manufacturer, and indirectly as it would affect his employes. Just what legislation would be wise, and how far it ought to go, would be hard to determine, but the question is one of legislative possibilities.

D. E. CUPPETT,—*Tucker County.*

Why must every tree be cut down along a roadway? Trees left 16 or 20 feet apart would not cause roads to remain muddy. In many parts of West Virginia one must drive through cleared lands without a tree for shade or to give rest to the eyes. Even the streams are left high and dry. I am aware that land must be cleared for farming purposes, but why cut the timber to the water's edge? Why not leave a strip twenty feet wide on either side of the streams to protect the ferns, honeysuckles, rhododendrons, and water plants? It would add a hundred fold to the beauty and value of farms, besides preserving the water so necessary for the land and for stock. I have observed that when a farmer is about to build a house, he usually cuts down all the trees near, or builds the house in the open where the sun beams down from morning till night. My ideal farm would be in the mountains, with fields on the hillsides and in the valleys, with trees sufficient for beauty, with old and new woodlands, trees along the roads everywhere, and on both sides of the lane leading to the house, houses painted or white-washed, streams sheltered with plants and trees, the spring surrounded with ferns and the spring-house covered with vines.

If the homes were thus made more beautiful, maybe the boys and girls would love them more.

HARRIET B. JONES, M. D.,—*Ohio County.*

Farmers are not raising enough sheep. There should be an experimental farm in every congressional district. An effective dog law would help. The remedy for much of the forest waste would be a Federal or State system of caretaking, or co-operation along that line.

GRAY SILVER,—*Berkeley County.*

Our people have been so accustomed to wasting, that any legislation which has for its purpose the restricting of that waste will necessarily be combatted, criticised, and ridiculed, and perhaps not become effective.

Before anything can be accomplished a great, broad system of education must be taken up in our State. We must make it possible for every man of affairs, for every newspaper writer, and for every public spirited and interested citizen to know his State, and to feel an interest in it. We must teach them how many acres of valuable forest we have, the kinds of timber and the values thereof, and the values in adjoining States, and what the conserving of these values means.

When timber lands, that have a value of $50 and $60 an acre, on a stumpage basis, are sold at $10 an acre, the manufacturer or cutter of that timber does not figure that he is called upon to conserve or save anything excepting the immediate commercial product.

In the olden days they made wood fires of cherry and walnut, hauled poplar for thirty, forty and fifty miles, and set fire to the spruce. I absolutely believe that lack of knowledge of the value of these woods was the only reason for this destruction.

Certain of our seams of coal are mined and others destroyed, or at least not utilized, and those that are mined are taken out in such a way that the veins remaining above the same will not be commerciably workable.

We connot see how we can be restricted around this industry, unless it be that we show the owners of these mines, and the holders of this coal, a commercial use for the fuel that they are now wasting.

Our State streams present remarkable opportunities for the development of water power, none of which, to my knowledge, has been expedited, or looked into to the extent that it should.

Our farm lands are valuable and productive, although I question very much whether the majority of our citizens take much interest in disseminating knowledge as to their values of productiveness.

Our natural gas and oil are the sources of wonderful wealth, and it is unquestionably true that we have no legislation of any nature that sets forth any reasonable restrictions, that will avoid wasting these products. Especially this relates to natural gas.

All of the foregoing statements are simply a knowledge which most of us possess, in an abstract manner, but when we desire to disseminate any information along these lines we find grave difficulties in our way.

Statistics and information relative thereto are not available in such a manner as would give us much knowledge of the values of our waste. This can only be obtained through careful research on the part of our government, and coupled with this research we must, in a conservative manner, set forth to the public the results, and do it in such a manner that the natural gas operator, that the oil operator, that the coal miner, or owner, that the manufacturer of lumber, and that the agriculturist will have before him facts and figures that cannot be disputed and will be convincing to him, that it is cheaper to save than it is to waste.

Now if you can start your work along these lines and the government will keep it up vigorously, and diligently, I believe that after-years will show that you have accomplished much more than would now appear possible.

H. R. WARFIELD,—*Monongalia County.*

Agricultural lands are not producing to their full capacity because not enough attention is paid to the rotation of crops and feeding the soil with green manure. As to marketing their crops to the best advantage, with us the farmers get about all that is coming to them. Better roads would enable them to market their crops in any kind of weather, and they could work their land in good weather. We have fine local markets here. Good tenant houses should be built, and a good class of immigrant farmers should be encouraged. We shall be fortunate if we can prevent the productive capacity of our forests from decreasing because of fire and the cutting of immature trees. Timber owners should sell only above a certain size, and the buyers should protect the young growth. Lumbermen should burn all refuse, and the State should pay men who fight fire. If lumbermen knew that cut-over land will produce another crop in twenty years, if properly managed, they would be less wasteful. West Virginia might co-operate with the Government by setting aside forest reserves, acquiring and planting waste places, and in giving object lessons in cutting and removing mature timber with least harm to immature growth.

ALEX. CLOHAN,—*Berkeley County.*

The young men can't be kept on the farms. Better roads would help, and a further remedy for the abondoned farm evil lies in bringing in immigrant farmers. Careless timber cutting has caused much waste of forests. Timber cutters should clean up. State laws are needed. Fire lines will lessen losses. Natural streams are not as pure as formerly, or as constant in flow. Waste has been great in development of mineral wealth, especially natural gas, and legislation is needed.

A. BLISS MCCRUM,—*Preston County.*

Good roads would help agriculture in West Virginia more than any one imagines. Immigrant farmers would help solve the abandoned farm problem, if anything can be done to bring them in. There ought to be laws requiring forest conservation, and the laws should be enforced. Fire losses can be lessened by adopting the United States plan. Loss of mineral wealth can be partly prevented by mining laws, if enforced.

JAMES A. STROTHER,—*McDowell County.*

There are two points of a general charcter, to which I wish briefly to refer.

Among so many questions of importance it is hard to decide which is first, but the preservation of forests and the conservation of water, in themselves and in their far reaching effects, gives them first claim. There are very large areas of cut-over timber lands now in this State and the amount constantly increasing, where the land is practically worthless except for timber growth. On account of taxes the owners cannot allow this land to re-forest, naturally or by planting. Thirty, forty or fifty years is too long for the owner to wait for returns, but only a day in the life of a state or nation. But for the state to purchase these lands and re-forest them would involve heavy taxation on the present generation and invite mismanagement if not graft. I believe that the owners should be permitted to register such lands as set aside solely for re-foresting and that they should be exempted from all taxation until the timber was marketed, and then the State should take in lieu of all back taxes a liberal percentage of the value at the time timber is sold. Under this plan, I believe many acres would be set aside for the benefit of the estates of the present owners. Our constitution in West Virginia would no doubt have to be changed before this could be done, but such a law properly guarded would, I believe, largely solve the problem of the best use to put our waste mountain lands. If these lands were let alone and protected from fire, nature would do the rest.

With the conservation of our waters it is different. The state or nation, probably both, should take charge of this. Droughts and floods here not only affect us in West Virginia greatly, but are also of great interest to citizens of Washington and New Orleans. I believe that great storage reservoirs should be built near the headwaters of our streams, where waters impounded during floods could be gradually released during low water period. Water powers could be developed that would ultimately more than pay the cost, in addition to saving our people the destruction to life and property that comes annually during great floods or droughts.

The government is preparing to spend much money in canalizing navigable streams. Might it not be well to investigate this matter of storage reservoirs to see if, among its other advantages, it could not be made to give us navigable streams the year around, without the construction of at least so many of these dams?

J. B. FINLEY,—*Wood County.*

So far as conservation can be reached by legislation, I would suggest the immediate passage of a forestry bill similar to the one submitted by the committee to the State Board of Trade; a bill along the lines of the Indiana statute to prevent the waste of natural gas; and if it were possible to pass it, I should like to see enacted a law similar to the Indiana statute forbidding the transportation of gas in pipes at more than a fixed pressure. The real purpose of the law being to embarrass its transportation. I doubt whether the legislature could now be persuaded to pass a statute of this kind. It was suggested once before but was resisted by the representatives of those counties in the State which get their gas by transportation. It was insisted that they would suffer as well as non-residents by the passage of such a measure.

JOHN W. DAVIS,—*Harrison County.*

The State and County should each bear a share of the road building, provided the County would build such roads as would come up to the standard.

It will take a generation or two to convert a forest destroying nation into one that will plant and preserve forests. Constant agitation of the subject will eventually bear fruit, and I also think the state or county might show a good example by buying in delinquent tax lands, planting them in forests and preserving them without privilege of selling them again at least for a number of years. This would perhaps be the best method of showing what can be done in this direction.

The forests and streams are so intimately related that we can do nothing to restore the flow of the streams until the hills are again covered with woods. Adulteration or rather fouling of streams should be prevented by law.

H. ZILLIKEN,—*Brooke County.*

There should be better roads; farm houses ought to be made more attractive; and there is need of immigrant farmers if good ones can be had. To increase the producing capacity of forests, take care of the timber left when the best has been removed, and strictly enforce fire laws.

W. A. CARROLL,—*Lincoln County.*

Grass ought to be brought oftener into rotation of crops, and farmers would profit by feeding more hay and grain on the land. Good roads will lead to more careful farming and better crops. In Jefferson County there are plenty of farmers for all the land, and there are no abandoned farms; but there is need of more intelligence. The people are blind to the fact that we have a future, and have not learned that it will pay to protect our forests. On my farm I have locust, hickory and oak growing on every foot of land that is too rough to farm, and it pays big. The State and Government should co-operate in the protection of forests along streams.

JOHN P. KEARFOOT,—*Jefferson County.*

The principal source of waste of forest resources are portable saw and stave mills which locate on tracts so remote that it pays to market nothing but the best. Thousands of dollars worth of merchantable stuff is left to rot or burn because it costs too much to haul it out. Good roads would help solve this problem as it would so many of the farmers' problems. The starting of a forest fire ought to be made a felony.

WILLIAM KIRK.—*Wood County.*

The game warden's and the fire warden's offices should be combined. The justices of the peace, the constables and all local officers should be assistants, with power to put out fires. The State should pay for it, and have recourse on the person setting the fire. The building of fire in the woods and failure to extinguish it should be a misdemeanor, and the wilful setting of a forest fire a felony. The State might co-operate with the Government in forest conservation by furnishing free the land needed for reserves.

A. D. WILLIAMS.—*Pocahontas County.*

It is a notorious fact, I think, that the farm lands of this State, or at least of this section, are not producing to their full capacity. At least most of them are not. The fault, I would say, is lack of intelligent culture and fertilization. Failure to diversify farming or to rotate crops is another reason. Too many farmers rely solely upon grain crops, while fruit, where within reach of market, or vegetables, could be grown to a great advantage. If the farmers were urged by the Directors of Farmer's Institutes and bulletins issued by the Agricultural Department and the Experiment Station to change their methods, perhaps some good might be accomplished.

Most of them in this section market their crops to a fair advantage, but too few of them have anything to market. Bad roads undoubtedly deter many from engaging in fruit culture.

Unquestionably it would be a great advantage if immigrants of a desirable character could be secured. They should be people who have been raised on farms in the old countries and who would make farm hands. The agricultural section in this end of the State have been drained of the best and most energetic of the young men raised on farms who have been induced to go to the cities and towns where there are manufacturing industries, during the recent years where wages there were high, higher than wages on the farms, until there is now a dearth of farm laborers. In this paticular section if some immigration could be induced from countries where truck-farming or fruit-growing is engaged in, it would be a Godsend to our people.

In this section the best timber, in fact nearly all of the timber accessible to the railroad, has been cut, except what is fit for mine props. It is now cut and hauled as far as twenty-five miles, that is oak lumber for car stock. The tops are allowed to lie in the woods and occasional fires are so fierce as to destroy the young growth of timber and make the lands desolate. If practical, more stringent laws should be enacted against setting out fires and some method devised whereby they could be more effectually enforced. Would it not be practical to have a fire marshal in each magisterial district, or two or three of them, paid a small salary to report on conditions and with authority to summon persons and compel them to fight fires whenever they break out? As it is at present, nobody interests himself in a forest fire unless there is danger that it may burn the house or fencing of himself or neighbor. It is absolutely useless to talk of reforesting the mountains that are cut over until the frequent recurrence of forest fires is prevented. The necessity of reforesting the mountains need not be urged. The great trouble to sections like this lies not so much in the loss of timber and the failure to provide a future supply as in fact that the streams are becoming unmanageable. They practically dry up in the summer, then sweep over the bottom lands at every rain, destroying or damaging the lands, and the erosion becomes so much greater on the hills and mountains as to more rapidly change the whole face of nature.

The streams are by no means as constant in their flow as formerly, due, of course, to destruction of the forests. In most places they are polluted with impunity. A single industry is allowed to pollute a whole river for lack of interest on the part of the public, or fear of inconvenience to the industry. Two years ago I procured an injunction against the U. S. Leather Co., operating a tannery at Moorefield, and saved the South Branch, one of the few pure streams in the State. The tannery only needed to construct a settling pool at a small cost, but until enjoined was rendering the water unfit for stock, killing the fish and endangering public health. In my judgment no subject demands more urgently the attention from the State Legislature than the preservation of the purity of our streams, both large and small.

The State could certainly co-operate with the Government in forest preservation. The time has now arrived when public sentiment must be aroused and relief secured through the State and National Legislatures, if any of our forests are to be saved, or those cut down are ever to be re-grown. It is very difficult to get the general public to take an intelligent interest in these questions. It seems to me the first and most desirable work is to provide some method of educating the individual citizen to the importance of individual action. This accomplished, all other necessary things will follow.

JOHN J. CORNWELL.—*Hampshire County.*

The one great drawback with our West Virginia farmers, in my opinion, is their failure, through ignorance or neglect, and there is no excuse for either, to apply proper methods of cultivation. In many places in West Virginia to my knowledge there is scarcely any preparation for the planting of crops. The ground is hastily and carelessly ploughed and very poorly cultivated. The use, especially the proper use of fertilizer is unknown, and many of our farmers make no effort to prevent erosion of their hillside farms. Consequently the soil has in many places been washed away. By exercising a little care nearly all erosion could be prevented. One simple method is to plow a ditch around the hillside at the top of each steep bank on it. This has two good results. It catches and holds the soil being washed from the bank above, and also holds the water, thus keeping the ground moist for a much longer period than it would otherwise be.

There is hardly a city, town, or even a village in West Virginia that can depend upon the West Virginia farmers for its supply of even the commodities produced in this State. It seems that the farmer does not grasp the fact that the best market for him is the home market. In fact in West Virginia many of our farmers do not even supply themselves with the common cereals, and if they do produce any surplus it is of such inferior quality there is no home market for it. We want our farmers to understand that it is just as cheap to produce a superior quality as an inferior quality; that it takes cultivation to produce a superior quality. I have seen as much produced on one acre as on five acres next adjoining just by proper preparation and cultivation of the one acre and lack of it on the five acres. The value of good roads cannot be estimated to the farmer. There is hardly a county in West Virginia but what some of the farmers have to pay more to market their products than it costs to import them from Chicago. This gives the farmer living hundreds of miles from here quite an advantage over our own farmers. Then good roads brings the farmers into closer touch with the outside world. It gives him an impetus to adopt better methods of farming and makes farm life more attractive. Good roads makes it possible for the farmer to drive into our towns and cities quickly and at all times of the year. The farmer's boy and girl can thus drive into town and hear lectures and attend the opera thus having all the advantages of the city with none of its drawbacks. And then driving, in itself, should be and would be one of the attractions and pleasures of farm life if we had good roads. Thus we see that good roads is one of the ways to prevent the "abandoned farm." Another thing that has made farm life unattractive, I know this by experience, is that the farmer must get out of bed at four o'clock in the morning and work till nine o'clock at night. The farmer should have regular hours for work just as the employed in the city, and should have regular hours for amusement. The toiling of many hours makes the farmer stupid, and he is thus rendered unfit to do his best work. I believe that by observing the proper hours and taking proper rest, he would be capable of doing much more in a less number of hours than in the many hours that he now toils. I am certain that it would do much to elevate the farmer class to keep the boys and girls on the farm.

Some of the best farmers that I know are immigrant farmers. There probably can be something done to bring some more such substantial farmers into West Virginia. I am inclined to believe that something along this line ought to be done; but this alone will not cure the evil.

If every farm in West Virginia had five or ten acres of forest, I believe that it would do much in helping climatic conditions. I remember very well the time when a small creek near my father's farm flowed constantly. There were thousands of good sized fish in this stream, but now the stream is entirely dry in the summer time, and, of course, there are no fish in it. In the winter time there are many floods in this creek. The water becomes very muddy, thus making it plain to be seen that the farms along it are being washed away.

W. C. GRIMES.—*Marshall County.*

I have yours of November 11th on my return from Hot Springs, and I note the printed circular that you inclose in your letter.

There are some very pertinent questions asked in that printed schedule of inquiry. In fact there is enough in it for a man to write a large book in answer and then not cover the subjects.

There is one particular point in the circular that I desire to call your attention to, and that is, the denuding of the hillsides and mountain sides of our State of timber and underbrush. There is no question in my mind but that is causing the great scarcity of water in our streams and we have noticed this more especially this year. I think it should be made obligatory upon those owning land that when they cut the large trees suitable for commercial purposes, that smaller trees under eight inches should be left and protected; when they are cutting the large timber out that a man should be punished for destroying timber under that size unless the land is to be cleared for agricultural purposes. And to clear our steep mountains and hillsides by taking all the timber and underbrush away, and using it for agricultural purposes, in my judgment is a great mistake. The land is very hard to till and in a few years the soil washes off and in the winter we have innumerable slips which make it next to impossible to use this land for tillable purposes.I would compel by law a man owing land to replant it in some kind of timber of quick growth or in trees that would be available for making posts or that could be used for other purposes on the farm. A law should be provided to send a man to the penitentiary who would wilfully or knowingly allow fire to start in our timber lands. We have been, I think, entirely too profligate in the destruction of our great wealth of timber in West Virginia and the old saying will hold good with us "that you never miss the water till the well runs dry." We will never miss the timber and its great influence on the rainfall and the other advantages it gives to the country until we have no forests.

After doing everything we can to hold the moisture in the underbrush and in the leaves and dead and down timber to supply our streams, then the next thing we should do would be to pass a stringent law to provide against the pollution of our streams. Then I favor most liberal appropriations of both the National Government and the State Government for constructing dams or reservoirs across our smaller rivers and our large creeks in the State where we could hold a reserve of water for just such droughts as we have had in the past four months. A great many of our mountain streams, if the water were held, would be available for manufacturing purposes as they are used all through New England. There is no reason why the interior as well as other portions of West Virginia, should not be made a manufacturing country with an assurance of profit as great or greater than is now made in New England where you will find a manufacturing establishment of some kind on almost every little stream throughout that wonderful New England country.

Jumping to another subject, in my opinion, there is nothing that would help the farmer and help our State or any State as much as good roads. Inland water-ways and good roads are the greatest of blessings to any community. They are far more valuable to the farmer than railroad or stage coach lines, and I have for years been in favor of working our convicts in the penitentiaries and jails, where they are sentenced for any length of time, on the roads. Then in a few years we could have good roads all over the entire State.

So far as bringing immigrants to our farms in West Virginia is concerned, I think it is hardly necessary. What we want is to make the farm so attractive that the boys and girls will stay on them instead of seeking employment in our cities, towns and villages.

N. B. SCOTT,—*Ohio County.*